

ABSTRACT

GUO, TIAN. Examining Low-impact Recreation Behavior – The Effects of Values, Attitudes, and Timing of Educational Messaging. (Under the direction of Dr. Roger L. Moore and Dr. Jordan W. Smith).

A considerable amount of previous research has documented the adverse impacts of recreation activities on the natural environment. These impacts, which include soil compaction and erosion, loss of vegetation and degraded wildlife habitat, can result in the severe degradation of ecosystem function and the quality of recreation experiences if left unmanaged. Promoting low impact recreation behaviors among visitors to natural areas is vital in order to protect natural resources while serving public recreation needs and facilitating the benefits associated with human-nature interactions. This dissertation examined low-impact recreation behaviors, focusing on three broad questions: 1) how have social-psychological theories guided low-impact recreation behavior research; 2) why do individuals comply with low-impact recreation behavioral recommendations; and 3) does the timing of educational messaging regarding compliance with low-impact recreation behavioral recommendations affect compliance with those behaviors.

Collectively, this dissertation was designed to contribute to the theoretical development of outdoor recreation research and to inform visitor use management. It is my hope that this dissertation will assist natural resource managers and researchers in their efforts to provide high quality outdoor recreation opportunities while protecting the natural resources upon which those opportunities depend.

© Copyright 2016 by Tian Guo

All Rights Reserved

Examining Low-impact Recreation Behavior – The Effects of Values, Attitudes and Timing of
Educational Messaging

by

Tian Guo

A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Parks, Recreation and Tourism Management

Raleigh, North Carolina

2016

APPROVED BY:

Dr. Roger L. Moore
Committee Co-Chair

Dr. Jordan W. Smith
Committee Co-Chair

Dr. Myron F. Floyd

Dr. Montserrat Fuentes

DEDICATION

This dissertation is dedicated to my parents, Xianyuan Guo and Zhiyun Tian. You did a good job.

献给我的父母，郭先原和田志耘。我爱你们。

BIOGRAPHY

Tian Guo graduated in December 2016 with a Ph.D. from the Department of Parks Recreation and Tourism Management (PRTM), and a Master of Statistics Degree from the Department of Statistics. Guo's general research interest is to promote mutually beneficial human-nature interactions through advancing our understanding of nature-based recreation outcomes and low-impact recreation behavior. Her current research focuses on the effects of personal values and environmental education on low-impact recreation behaviors. Her long-term research and teaching interests extend to the application of data sciences in natural resource management and promotion of community wellbeing. Her past research experience involves state parks economic impact studies, cross-cultural comparisons of outdoor recreation constraints, and case studies of community and sustainable tourism. Guo has also taught a required core course about analysis and evaluation for undergraduate students and guest lectured on nature-based recreation, ecological issues in tourism, and international tourism. She holds degrees from Sichuan University (BS, MS) in China, and the University of Minnesota (MS). In the fall of 2016, Guo will join the Leahy Lab in the School of Forest Resources at the University of Maine to continue her research on human-dimensions of natural resources as a postdoctoral research fellow. Off-campus, Guo is an Asian cuisine enthusiast and enjoys travelling with friends.

ACKNOWLEDGMENTS

I would like to first thank the 1,489 Appalachian Trail hikers and the 67 undergraduate students from North Carolina State University who generously donated their time for this project and shared their passion for nature and people. Also, my sincerest thanks to the Department of Parks, Recreation and Tourism Management and Appalachian Trail Conservancy for funding this dissertation. It has been an absolute pleasure to work with Morgan Sommerville, Laurie Potteiger, and Tenny Webster from Appalachian Trail Conservancy on this project.

I must also thank the faculty members who have served on my committee. To my co-chair Dr. Roger Moore my mentor, friend, great writer and thinker: you showed me what being an academic really means. To my co-chair Dr. Jordan Smith, who contributed tremendous time, effort and insight on this project: I am always inspired by your vision and deep understanding of research and your concise writing style. To Dr. Myron Floyd, who always asks the right questions that propel the project to a deeper level: I really enjoyed working with you. To Dr. Montserrat Fuentes, who generously provided advice and feedback on issues that were far beyond data analysis techniques: thank you for teaching me the value of integrating data science to practical issues. Finally, to Dr. Dennis Boos: I appreciate you generously stepping in for the defense process.

I am very grateful to my family, friends and colleagues. There are so many of you who supported, encouraged, and compelled me to grow; I cannot possibly make a complete list. My four years in Raleigh would not have been the same without you.

Thank you God; you make the impossible happen.

TABLE OF CONTENTS

LIST OF TABLES.....	ix
LIST OF FIGURES	x
CHAPTER 1: INTRODUCTION	1
References.....	4
CHAPTER 2: A REVIEW OF EMPIRICAL LOW-IMPACT RECREATION BEHAVIOR STUDIES: THE USE OF SOCIAL-PSYCHOLOGICAL THEORIES IN PREDICTION MODELS AND BEHAVIOR CHANGE INTERVENTIONS	6
Abstract	6
Introduction.....	7
Methods.....	11
Article Search and Selection.....	12
Coding and Analysis	13
Findings.....	17
Social-Psychological Predictors.....	17
Predictability of Social-Psychological Models	19
Behavioral Change Intervention	19
Discussion	22
Complex Human Behavior	23
Theory and Effective Behavioral Change Interventions.....	26
Limitation, Future Studies and Implications.....	30
References.....	32
Table 2. 1. Keywords used in article search	40
Table 2. 2. Socio-psychological factors conceptualized as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations in past studies.....	41
Table 2. 3. Social psychological predictors examined in previous research	42
Table 2.4. Socio-psychological factors tested using factorial environmental design.	43
Table 2.5. Socio-psychological factors targeted in theory-based behavioral change studies.	
.....	44
CHAPTER 3: THE INFLUENCE OF BASIC VALUES ON COMPLIANCE WITH LOW-IMPACT RECREATION BEHAVIORAL RECOMMENDATIONS	45
Abstract	45
Introduction.....	46
Value System	49
Values-Low-impact Recreation Behavior Consistency	50
Mediation Models of Values-Attitudes-Behavior.....	52
Methods.....	54
Data Collection	54
Data Analysis	59
Results.....	61
Respondents' Profile.....	61
Descriptive of Compliance and Values.....	62
Value-Behavior Consistency	63
Values-Attitudes-Behavior Mediation Models	66

Discussion	69
Limitations and Future Research	71
Managerial Implications	73
Conclusions.....	73
Reference	74
Table 3. 1. Definitions of Schwartz' basic value types and their hypothesized correlation with compliance with low impact recreation behavioral recommendations.....	82
Table 3. 2. Respondents' profile.....	83
Table 3. 3. Summary of respondents' values.....	84
Table 3. 4. Pearson correlation coefficients between values types and compliance with low impact recreation behavioral recommendations.	87
Table 3. 5. Model fit indices.....	88
Table 3. 6. Standardized path coefficients and R ² for the fully mediated simple model for the recommended low-impact recreation behavior of digging a cathole when a privie/outhouse is not available.	89
Table 3. 7. Standardized path coefficients and R ² for the fully mediated simple model for the recommended low-impact recreation behavior of camping only on previously used campsites.....	90
Table 3. 8. Standardized path coefficients and R ² for the fully mediated simple model for the recommended low-impact recreation behavior of using canister to store food and other smellable items.....	91
Figure 3. 1. The motivational circle of values according to the refined theory of basic values adopted from Schwartz and Butenko. 2014.....	92
Figure 3. 2. The Cognitive hierarchy model of behavior (adopted from Perry-Hill et al., 2014)	93
Figure 3. 3. Conceptual framework of the value-attitude-behavior mediation models. The mediation models include: 1) a fully mediated simple model; (2) a partially mediated simple model; (3) a parallel complex model; and (4) a chain complex model.	94
CHAPTER 4: DOES THE TIMING OF EDUCATIONAL MESSAGING INFLUENCE COMPLIANCE WITH LOW-IMPACT HIKING RECOMMENDATIONS?	95
Abstract	95
Introduction.....	96
Theoretical Background.....	99
Methods.....	103
Study Design.....	103
Materials and Measures	106
Data Analysis	111
Results.....	115
Participants' Profiles	115
RQ 1. Does the timing of a low-impact hiking educational message influence individuals' compliance with low-impact hiking recommendations?	116
RQ 2. Does the timing of a low-impact hiking educational message influence individuals' knowledge levels and retention of the information delivered through that message?.....	117
RQ 3. Does the timing of a low-impact hiking educational message influence individuals' attitudes towards two low-impact hiking behaviors?.....	119
Discussion	121

Managerial Implications	124
Limitations and Future Research	126
Conclusions.....	129
References.....	130
Table 4. 1. Participant profile.	135
Table 4.2. Compliance rates with low-impact hiking recommendations by group and photos.	136
Table 4.3. Percentage of individuals who correctly identified three, two, or one knowledge item from post-survey data.	137
Table 4.4. Participants' selection accuracy rates from post-survey by group and knowledge items from post-survey data.....	138
Table 4.5. Participants' selection accuracy rates by experimental groups and pre-/post-surveys.	139
Table 4.6. Descriptive statistics of attitudes toward walking through any puddles, mud, or rugged spots on the trail, rather than walking around them from post-survey data.....	140
Table 4.7. Descriptive statistics of attitudes toward walking on wood or rock steps rather than around them from post-survey data.	141
Table 4.8. Comparisons of attitudes toward walking through any puddles, mud, or rugged spots on the trail, rather than walking around them among three groups from post-survey data.....	142
Table 4.9. Means of attitudes toward walking through any puddles, mud or rugged spots on the trail, rather than walking around them by pre-/post surveys and experimental groups.	143
Table 4.10. Comparison of attitudes toward walking on wood or rock steps rather than around them among the two treatment groups and the Control group from post-survey data.	144
Table 4.11. Means of attitudes toward walking on wood or rock steps rather than around them by pre-/post surveys and experimental groups.....	145
Figure 4.1. Screen-shot of the educational message including the video and summary statements.....	146
Figure 4.2. Trail photos used in this study. From top left to bottom right are trail conditions 1 through 7. Trail conditions 1 through 4 depicted muddy and wet trails. Trail conditions 5 through 7 depicted steep rails with steps.	147
CHAPTER 5: CONCLUSION	148
Reasons for Compliance and Non-Compliance	148
Behavioral Change Interventions.....	150
Theory-based Research Approach	151
Managerial Implications	153
References.....	154
APPENDICES	155
Appendix A Summary of Social-Psychological Factors Studied in less than Two Prediction Model Study for Chapter Two	156
Appendix B Survey Instrument One for Chapter Three	158
Appendix C Survey Instrument Two for Chapter Three	188
Appendix D Pre-Notice Survey Invitation and Follow-up Reminders for Chapter Three	226
Appendix E Summaries of Attitudinal Factors for Chapter Three	233
Appendix F Pre-test Survey Instrument for Chapter Four.....	235

Appendix G Post-test Survey Instrument for Chapter Four.....	238
Appendix H Figures of Researcher's Position during Experiment For Chapter Four	244

LIST OF TABLES

Table 2. 1. Keywords used in article search	40
Table 2. 2. Socio-psychological factors conceptualized as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations in past studies.....	41
Table 2. 3. Social psychological predictors examined in previous research	42
Table 2.4. Socio-psychological factors tested using factorial environmental design.....	43
Table 2.5. Socio-psychological factors targeted in theory-based behavioral change studies.....	44
Table 3. 1. Definitions of Schwartz' basic value types and their hypothesized correlation with compliance with low impact recreation behavioral recommendations.....	82
Table 3. 2. Respondents' profile	83
Table 3. 3. Summary of respondents' values.	84
Table 3. 4. Pearson correlation coefficients between values types and compliance with low impact recreation behavioral recommendations.	87
Table 3. 5. Model fit indices.	88
Table 3. 6. Standardized path coefficients and R ² for the fully mediated simple model for the recommended low-impact recreation behavior of digging a cathole when a privie/outhouse is not available.	89
Table 3. 7. Standardized path coefficients and R ² for the fully mediated simple model for the recommended low-impact recreation behavior of camping only on previously used campsites.	90
Table 3. 8. Standardized path coefficients and R ² for the fully mediated simple model for the recommended low-impact recreation behavior of using canister to store food and other smellable items.	91
Table 4. 1. Participant profile.	135
Table 4.2. Compliance rates with low-impact hiking recommendations by group and photos..	136
Table 4.3. Percentage of individuals who correctly identified three, two, or one knowledge item from post-survey data.	137
Table 4.4. Participants' selection accuracy rates from post-survey by group and knowledge items from post-survey data.	138
Table 4.5. Participants' selection accuracy rates by experimental groups and pre-/post-surveys.	139
Table 4.6. Descriptive statistics of attitudes toward walking through any puddles, mud, or rugged spots on the trail, rather than walking around them from post-survey data.....	140
Table 4.7. Descriptive statistics of attitudes toward walking on wood or rock steps rather than around them from post-survey data.	141
Table 4.8. Comparisons of attitudes toward walking through any puddles, mud, or rugged spots on the trail, rather than walking around them among three groups from post-survey data.	142
Table 4.9. Means of attitudes toward walking through any puddles, mud or rugged spots on the trail, rather than walking around them by pre-/post surveys and experimental groups.....	143
Table 4.10. Comparison of attitudes toward walking on wood or rock steps rather than around them among the two treatment groups and the Control group from post-survey data.	144
Table 4.11. Means of attitudes toward walking on wood or rock steps rather than around them by pre-/post surveys and experimental groups.....	145

LIST OF FIGURES

Figure 3. 1. The motivational circle of values according to the refined theory of basic values adopted from Schwartz and Butenko. 2014.....	92
Figure 3. 2. The Cognitive hierarchy model of behavior (adopted from Perry-Hill et al., 2014). ..	93
Figure 3. 3. Conceptual framework of the value-attitude-behavior mediation models. The mediation models include: 1) a fully mediated simple model; (2) a partially mediated simple model; (3) a parallel complex model; and (4) a chain complex model.	94
Figure 4.1. Screen-shot of the educational message including the video and summary statements.	146
Figure 4.2. Trail photos used in this study. From top left to bottom right are trail conditions 1 through 7. Trail conditions 1 through 4 depicted muddy and wet trails. Trail conditions 5 through 7 depicted steep rails with steps.....	147

CHAPTER 1: INTRODUCTION

Public lands and waters in the U.S. are highly valued and used for multiple purposes, including recreation. Despite the extensive benefits generated through ecosystem services and nature-human interactions, recreational use inevitably generates environmental impacts, such as soil compaction, vegetation trampling, wildlife disturbances and water quality degradation (Marion, Leung, Eagleston, & Burroughs, 2016). Each of these and other impacts degrade how ecosystems function and jeopardize the ability of natural resource managers to simultaneously protect natural resources and provide desirable recreation opportunities (Marion et al., 2016). Promoting low-impact recreation behaviors among visitors to natural areas is vital for natural resource managers to achieve their goals.

An extensive number of studies have examined why individuals behave in certain ways in outdoor recreation settings, with the goal being to develop effective ways to influence and alter undesirable behaviors (Alfano & Arthur, 1976; Christensen, Johnson, & Brookes, 1992; Knopf & Andereck, 2004; Manning, 2011; Marion & Reid, 2007; Vande Kamp, Johnson, & Sewaringen, 1994). Recreation researchers have developed a large body of knowledge on this topic (Burn & Winter, 2007; Doucette & Cole, 1993; Knopf & Andereck, 2004; Manning, 2003, 2011; Marion & Reid, 2007; Vande Kamp et al., 1994). However, Knopf and Andereck (2004) observed a decline in production of low-impact recreation studies, suggesting a need to evaluate the existing research's theoretical groundings in relation to visitor education practices, examine omitted factors in explaining why recreationists behave in certain ways and test diverse behavior change approaches to fully capture the complexity of outdoor recreationists' behaviors.

To help address this need, the objectives of this dissertation were:

- 1) To advance the field's conceptualization of why recreationists' do or do not comply with low-impact recreation behavioral recommendations, and to identify clear conceptual pathways from relevant socio-psychological factors to behavioral change interventions;
- 2) To determine if, and to what extent, individuals' compliance with low-impact recreation behavioral recommendations are consistent with their basic values, and if values influence compliance with low-impact recreation recommendations through mediating attitudinal factors; and
- 3) To examine whether or not when an educational message is received influences compliance with recreationists' attitudes, knowledge, and behavioral intentions regarding low-impact hiking behavior.

To achieve the first objective, I conducted an integrated literature review assessing how social-psychological theories have been used by researchers to understand and influence compliance with low-impact recreation behavioral recommendations. To achieve the second objective, I examined the relationships between values and the actual behaviors of Appalachian Trail long distance hikers using an on-line survey. To achieve the third objective, I tested how the timing of educational messaging influences individuals' compliance with low-impact hiking behavioral recommendations using a laboratory-based experiment.

In these studies, I drew upon social-psychological theories including Schwartz's value theories, cognitive hierarchy theory, the Theory of Planned Behavior and McGuire's Information Process Paradigm. I used a mix of research designs including an integrated literature review, a cross-sectional on-line survey, and a laboratory-based experiment with randomization and control. Collectively, this dissertation hopes to contribute to the low-impact recreation theory and practice by evaluating how researchers have studied behavior from a social-psychological

perspective, examining social-psychological constructs that have been less studied in existing literature and testing ways to change recreation behavior that are of theoretical and managerial interests.

The dissertation was also designed to meet the practical needs of the Appalachian Trail Conservancy (ATC). In partnership with the National Park Service, USDA Forest Service and many other partners, the ATC is tasked with preserving the Appalachian Trail and providing unique hiking opportunities. However, these goals have been increasingly challenged due to hikers who do not adhere to rules and guidelines designed to protect natural resources and the experiences of other hikers. Although significant progress has been made in educating hikers about responsible use behaviors such as the Appalachian Trail Leave No Trace campaign, considerable challenges remain and will almost certainly intensify. These issues are not unique to the Appalachian Trail but apply to diverse natural areas. To help address this need (primarily through the second study in this dissertation), I have been working with ATC to collect behavioral and perceptual information about their hiking publics. In the third study, I employed an educational message with prospective Appalachian Trail hikers as the target population. I used an educational video developed by ATC in the message, and gauged participants' behavioral intentions using photos taken on one part of the Appalachian Trail. It is my hope in addition to make a contribution to theory the information gathered from these studies will help ATC evaluate some of their existing educational materials and consider the opportunity to integrate more off-site educational efforts.

This dissertation is organized into five chapters. The current chapter is an overall introduction addressing the background objectives of this research. Chapters two through four

report on separate but related studies that comprise the research itself. The fifth and final chapter discusses the overall findings or the research and its implications.

References

- Alfano, S. S., & Arthur, W. M. (1976). *Vandalism and outdoor recreation: symposium proceedings Pacific Southwest*. Berkeley, CA.
- Burn, S. M., & Winter, P. L. (2007). *Environmental intervention handbook for resource managers: a tool for proenvironmental behavior change 2nd Edition*. Riverside, CA.
- Retrieved from
http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1029&context=psycd_fac
- Christensen, H. H., Johnson, D. R., & Brookes, M. H. (Eds.). (1992). *Vandalism : research , prevention and social policy*. Porland, OR.
- Doucette, J. E., & Cole, D. N. (1993). *Wilderness visitor education: information about alternative techniques* (Vol. General Te).
- Knopf, R. C., & Andereck, K. L. (2004). Managing deprecative behavior in natural settings. In M. J. Manfredo, J. J. Vaske, B. L. Bruyere, D. R. Field, & P. J. Brown (Eds.), *Society and natural resources: a summary of knowledge prepared for the 10th International Symposium on Society and Resource Management*. Jefferson, MO: Modern Litho.
- Manning, R. E. (2003). Emerging principles for using information/education in wilderness management. *International Journal of Wilderness*, 9(1), 20–27. Retrieved from
<http://issuu.com/ijwilderness/docs/vol-09.no-1.apr-03/21?e=1888065/6763369#>
- Manning, R. E. (2011). Managing outdoor recreation: alternative management practices. In

- Studies in Outdoor Recreation: Search and Research for Satisfaction* (3rd Eds., pp. 273–321). Corvallis, OR: Oregon State University Press.
- Marion, J. L., Leung, Y., Eagleston, H., & Burroughs, K. (2016). A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry*, 114(May), 1–17. doi:10.5849/jof.15-498
- Marion, J. L., & Reid, S. E. (2007). Minimising visitor impacts to protected areas: the efficacy of low impact education programmes. *Journal of Sustainable Tourism*, 15(1), 5–27. doi:10.2167/jost593.0
- Vande Kamp, M. E., Johnson, D. R., & Sewaringen, T. C. (1994). *Deterring minor acts of noncompliance a literature review*. Seattle, WA.

**CHAPTER 2: A REVIEW OF EMPIRICAL LOW-IMPACT RECREATION BEHAVIOR
STUDIES: THE USE OF SOCIAL-PSYCHOLOGICAL THEORIES IN PREDICTION MODELS
AND BEHAVIOR CHANGE INTERVENTIONS**

Abstract

To advance low-impact recreation behavior research, we reviewed 56 empirical studies, classifying them as either *prediction model studies* or *behavioral change studies* depending on their use of social-psychological theories in predicting or influencing compliance with low-impact recreation behavioral recommendations. Our analysis revealed a total of 55 social-psychological constructs that have been used to predict compliance. Attitudes toward the low-impact recreation behavior was the most commonly studied predictor. On average, *prediction model studies* accounted for 28.2% of variance in recreationists' compliance with low-impact recreation behavioral recommendations. One-half of the *behavioral change studies* tested theory-based behavioral change interventions while half tested practice-based interventions; the practice-based interventions were significantly related to compliance with low-impact recreation behavioral recommendations more often than the theory-based interventions. We discuss the insufficiency of current social-psychological models and theory-based interventions and propose a new research agenda that is more focused on the context-dependent and temporally-dynamic nature of low-impact recreation behavior.

Keywords: low-impact recreation behavior; behavior change interventions; prediction models; social-psychological theory applications; integrated review

Introduction

A considerable amount of previous research has documented the impacts of recreation activities on the natural environment. These impacts, which include soil compaction and erosion, loss of vegetation and wildlife habitat, can result in the severe degradation of how ecosystems function (Marion, Leung, Eagleston, & Burroughs, 2016). Promoting low-impact recreation behaviors among visitors to natural areas is vital to protect natural resources while serving public recreation needs and promoting the benefits associated with human-nature interactions. Many studies have examined why individuals behave in certain ways at outdoor recreation settings, with the goal being to identify effective ways to influence and alter undesirable behaviors (Alfano & Arthur, 1976; Christensen, Johnson, & Brookes, 1992; Knopf & Andereck, 2004; Manning, 2011; Marion & Reid, 2007; Vande Kamp, Johnson, & Sewaringen, 1994). Recreation researchers are beginning to develop a solid body of knowledge on this topic; the state of the science has been summarized in a number of literature reviews leading to numerous guidelines about how natural resource managers can best use education and behavioral interventions to guide visitor behavior (Burn & Winter, 2007; Doucette & Cole, 1993; Knopf & Andereck, 2004; Manning, 2003, 2011; Marion & Reid, 2007; Vande Kamp et al., 1994).

A tradition of low-impact recreation behavior research is to apply theories from other social science disciplines, particularly social-psychology, to specific outdoor recreation management challenges (Knopf & Andereck, 2004). Several reviews have summarized the social-psychological theories that have guided low-impact recreation behavior research. These theories include: the Theory of Planned Behavior and the Theory of Reasoned Action, the Theory of Moral Reasoning and the Theory of Model Judgment, Norm Activation Theory, the Elaboration Likelihood Model of Persuasion, and a variety of persuasive communication theories

(Knopf & Andereck, 2004; Marion & Reid, 2007; Vande Kamp et al., 1994). Despite the abundant use of theory in this line of research, opportunities exist to advance the integration of different theories for the purposes of better understanding why outdoor recreationists do, or do not, comply with low-impact recreation behavioral recommendations.

Many of the social-psychological theories that have guided low-impact recreation research have been used for decades. For example, the Theory of Planned Behavior, Theory of Reasoned Actions, Knolberg's Theory of Moral Development, Norm Activation Theory, and Elaboration Likelihood Models, were all established in the 1970s and 80s. Despite the contributions these theories have made, conceptualizations of human behavior have evolved significantly, particularly within the field of social-psychology. The traditional view of behavior as a single action resulting from rational and deliberate calculations has been challenged as an oversimplification (Kollmuss & Agyeman, 2002). More recent research suggests behavior should be examined as a stream of actions, the direction of which is determined by the interplay of past behaviors, personal factors (both cognitive and affective), social interactions, and environmental factors (Zajonc, 1980; Plemmons & Weiss, 2013; Dalal & Hulin, 2008). This dynamic and multi-faceted conceptualization of human behavior suggests low-impact recreation studies should not be based on a single theory, but integrate multiple-theories accounting for the interplay of personal and environmental factors. In fact, the number of social-psychological constructs outdoor recreation researchers have adopted from different theories is growing. However, questions remain about what personal or contextual constructs are most important (if there are most important constructs) or what constructs are most important in specific social circumstances and/or outdoor recreation settings.

How to transfer the increasingly complex theoretical understanding of low-impact recreation behavior to visitor use management strategies is another key question regarding how to advance low-impact recreation research. Outdoor recreation researchers have directly tested behavioral change interventions to inform visitor education and information programs. However, empirical studies have produced an increasing number of mixed findings about what types of messages are most effective in influencing compliance with low-impact recreation behavioral recommendations. For example, there is no empirical consensus as to whether managers should use sanctions versus interpretive signs or attempt to invoke fear versus making moral appeals to change behavior (for a summary see Ward and Roggenbuck, 2003). There are still doubts about whether environmental education targeting knowledge and attitudes is effective enough to change environmentally-harmful recreation behaviors; these doubts are fueled by unsettled theoretical debates such as the inconsistent relationships between attitudes and behavior (Kim, 2012; Park, Manning, Marion, Lawson, & Jacobi, 2008; Weston, Schlacher, & Lynn, 2014). Unable to suggest consistent and actionable findings, outdoor recreation researchers are weakening their relevance to natural resource management; this may have contributed to the decline in production of low-impact recreation studies observed by Knopf and Andereck (2004).

Low-impact recreation research needs an updated conceptual framework that includes an integrated conceptualization of how different social-psychological processes affect compliance with low-impact recreation behavioral recommendations and, additionally, how compliance is affected by different behavioral change interventions. Toward this end, we conducted a review of empirical low-impact recreation behavior studies, examining their uses of social-psychological theories. We compiled and analyzed a sample of 56 empirical studies published between 1970 and 2015 that attempted to predict compliance with low-impact recreation behavioral

recommendations or to assess efforts designed to influence compliance. Our analyses focused on how these studies have used social-psychological constructs to predict and conceptualize changes in compliance. We addressed three related research questions:

RQ 1. What socio-psychological constructs have been analyzed as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations?

RQ 2. How well did the social-psychological models predict compliance/non-compliance with low-impact recreation behavioral recommendations?

RQ 3. What behavioral change interventions have been developed that use social-psychological theory to promote compliance with low-impact recreation behavioral recommendations?

Compared to traditional literature reviews, the goal of this study was not to verify existing theories, develop new ones, or synthesize knowledge from individual studies, which are available through previous reviews (Knopf & Andereck, 2004; Manning, 2011; Marion & Reid, 2007). The ultimate goals were to advance the field's conceptualization of why recreationists do or do not comply with low-impact recreation recommendations, and to identify clear conceptual pathways from relevant socio-psychological predictors to behavioral change interventions. We did not conduct an exhaustive review. Instead, we focused on the core body of the literature that has influenced this line of research and that is most likely to influence future low-impact recreation research and natural resource management. We did not conduct a meta-analysis for the effects of specific social-psychological factors. Instead, we posed the above research questions; sampled past studies; analyzed their theoretical foundations, methods, and findings; and interpreted the results. This process fits Jackson (1980) and Cooper (1988)'s descriptions of an integrative review that aims to infer "generalizations about substantive issues from a set of

studies directly bearing on those issues" (Jackson, 1980, p. 438.). The issues we focused on were how social-psychological theories have been used to explain compliance/noncompliance with low-impact recreation behavior, how these theories have guided behavioral change interventions, and what the future direction of low-impact recreation research should be.

Methods

This review focused on low-impact recreation behavior. Such behavior belongs to the broader concept of 'environmentally significant behavior', which Stern (2000) defined as behaviors that change "the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself" (p. 408). We adopted this impact-oriented definition and focused on recreation behaviors that have direct environmental impacts, such as travelling on trails, camping, disposing of human waste and interactions with wildlife. Researchers have used other terms to describe this behavioral phenomenon including responsible recreation behavior, minimum impact recreation behavior, Leave No Trace behavior, compliant/noncompliant behavior, as well as depreciative recreation behavior and vandalism. Previous research has defined and bounded outdoor recreationists' behavioral patterns in a variety of ways. Some research focused exclusively on park-specific pro-environmental behaviors that have direct environmental impacts such as littering (e.g., Brown, Ham, & Hughes, 2010), walking off designated trails (e.g., Park, et al., 2008) and feeding wild animals (e.g., Marion, Dvorak, & Manning, 2008), while others focused on broader environmentally-responsible behavior including park specific behaviors (Cheng & Wu, 2015; Halpenny, 2010; Lee & Jan, 2015; Van Riper & Kyle, 2014; Wynveen, Connally, & Kyle, 2013). We did not summarize studies examining recreation behaviors that indirectly influence recreation settings such as voting for natural resource related laws (Vaske & Donnelly, 1999) or engaging in pro-

environmental behavior at home (Vaske & Kobrin, 2001). We consider these off-site recreation-related pro-environmental behaviors to be unique behavioral phenomena that warrant separate reviews.

Article Search and Selection

We compiled our list of empirical studies of low-impact recreation behavior through a two-step process. First, we conducted a systematic search through *Web of Science* using a variety of keywords (Table 2.1). For example, we searched for articles that included at least one word or phrase from “recreation”, “park”, “protected areas”, or “sustainable tourism”, and the phrase “responsible behavior”; this resulted in 267 returns. After examining the titles (and abstracts if needed) of these articles, we found 60 articles to be relevant to the scope of this review. We then reviewed the bibliographies of articles identified in the first step and identified 21 more that also seemed relevant. In the article selection process, we limited our focus to empirical studies related to predicting or influencing behaviors and excluded theoretical or conceptual work (e.g., Ham & Krumpe, 1996). As a selection criterion, all of the studies we reviewed included a behavior or behavioral intention variable. Studies focused on attitudes or beliefs towards low-impact recreation behavior only, such as those by D’Antonio and her colleagues (2012) and Taff and his colleagues (2011), were excluded. Studies on redistributing visitors (e.g., Lucas, 1981) were excluded from the review as well. We consider the body of research on visitor distribution to be a separate topic from low-impact recreation behavior worthy of a separate review. How visitors’ travel patterns impact outdoor recreation settings differs from how direct interactions between individuals and natural resources influence the environment (e.g., trampling vegetation, feeding wildlife), which depends on the accumulative effects of individual actions and the characteristics of specific areas. There is also a separate set of theories and methods to explain visitors’ spatial

behaviors and their decisions regarding which parts of an outdoor recreation setting to visit.

Future reviews should incorporate such broader studies.

The final list of articles reviewed in this integrated review consisted of 81 empirical studies; these included 56 refereed journal articles, 12 dissertations/theses, seven conference proceedings, and six technical reports¹. The earliest article was published in 1972 by Clark, Hendee, and Burgess, and the most recent were six published in 2015 (Cheng & Wu, 2015; Goh, 2015; Lee & Jan, 2015; Lee, Jan, & Huang, 2015; Zhang, Zhang, Zhang, et al., 2015; Kidd, Monz, & D'Antonio, et al. 2015). As mentioned earlier, we acknowledge this list of empirical studies on low-impact recreation behavior might not be exhaustive, particularly for dissertations/theses, conference proceedings and technical reports. A thorough search of the latter forms of studies will require better access to scattered and specialized databases (e.g., databases maintained by natural resource management agencies for technical reports). The studies we compiled are those searchable through commonly used databases which means they are more likely to be accessed by outdoor recreation researchers to guide future research. Many of the articles we reviewed in this study have been cited widely, suggesting their potential influence on existing literature. We consider our list of compiled articles to be the core body of low-impact recreation literature.

Coding and Analysis

Selected articles were entered into a spreadsheet for coding and thematic development. The first author read each article and took notes about the salient theoretical and methodological aspects and the implications of each. Three categories of studies emerged from this first round of reviews based on how low-impact recreation behavior was conceptualized and examined. Studies

¹ If a study was reported in a peer-reviewed journal article and a dissertation/thesis, we only summarized the peer-reviewed journal article.

in the first category built theoretical models of low-impact recreation behavior using social-psychological constructs as predictors. These studies employed regression analysis, path analysis or structural equation modeling. Studies in the second category developed and tested behavioral change interventions. These involved field-based or laboratory-based experiments with behavioral change interventions as treatments. Finally, studies in the third category evaluated existing visitor education efforts or compared the characteristics of users in relation to their compliance/non-compliance with low-impact recreation behavioral recommendations, using a variety of methods including cluster analysis and ANOVA. A total of 25 studies were coded into the first category (referred to as *prediction model studies*), 31 studies were assigned to the second category (referred to as *behavioral change studies*), and 25 studies fell into the third category (referred to as *comparison and evaluation studies*). To address our research questions, we focused only on the 56 *prediction model* and *behavioral change studies* for further analysis. It is worth noting that the majority (64%) of the *comparison and evaluation studies* also explicitly reported some social-psychological theories as their guiding framework. However, they applied the social-psychological theories in more diverse ways than the *prediction model* and *behavioral change studies* (e.g., categorizing visitors based on their social-psychological factors and then compare their behaviors).

Coding for RQ 1 and RQ 2.

We further coded the 25 *prediction model studies* in order to address RQ 1 (i.e., What socio-psychological constructs have been analyzed as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations?), and RQ 2 (i.e., How well did the social-psychological models predict compliance/non-compliance with low-impact recreation behavioral recommendations?). In a spreadsheet, the first author recorded verbatim what social-

psychological constructs were used in each model as predictors to explain the compliance/non-compliance with low-impact recreation behavioral recommendations. We called these constructs ‘predictors’ in *prediction models studies*, and ‘factors’ in *behavioral change* studies. Our rationale was that each ‘predictor’ might relate to compliance/non-compliance with low-impact recreation behavioral recommendations. However, to confirm the relationship (i.e., to call it a ‘factor’) requires further examination such as experimental studies. Each predictor’s estimated coefficient and significance, and the proportion of the variance in the measure of behavior being accounted for by the overall prediction model were also recorded. Since the coding process was straightforward, we did not have concern about the use of a single coder. For studies reporting multiple models for varied behaviors at different locations, we recorded information from all the models. For studies that used stepwise regression, we only recorded information from the final model. For studies using structural equation modeling or path analysis, we included both indirect and direct social-psychological predictors of compliance/non-compliance with low-impact recreation behavioral recommendations.

The initial coding resulted in a list of 59 social-psychological predictors in social-psychological models of compliance/non-compliance with low-impact recreation behavioral recommendations. Some predictors appeared in only one or two studies, which might be due to poorly-defined terminology rather than indicating distinct social-psychological constructs. A further examination of the definitions and measurement of these social-psychological predictors revealed some predictors were conceptualized and measured in essentially the same way but named differently. These predictors included: 1) attitudes towards the behavior and behavioral beliefs²; 2) subjective norms and normative beliefs; 3) perceived control and control beliefs; and

² Someone could argue that beliefs are distinct from attitudes. Theoretically, the original Theory of Planned Behavior did conceptualize beliefs as antecedents of attitudes, suggesting beliefs and attitudes are distinct constructs.

4) ascriptions of responsibility and personal attribution. Each pair of wording was considered the same predictor. We decided to retain the rest of the predictors using the authors' original wordings³. Finally, some social-psychological predictors were examined as unidimensional constructs or a set of related constructs (e.g., place attachment, and its dimensional constructs of place dependence, place identity, place affect and social bonding). In these cases we included both the overarching construct and its sub-components. We tallied the number of articles and models examining each social-psychological predictor as well as the number of significant direct or indirect effects of these predictors on compliance/non-compliance with low-impact recreation behavioral recommendations. The odds of a predictor being found significant were calculated by dividing the number of models in which the predictor was significant by the number of models in which the predictor was not significant. We also conducted descriptive analysis on R² on the model level.

Coding for RQ 3.

We coded and analyzed the 31 *behavior change studies* in order to address RQ 3 (i.e., What behavioral change interventions have been developed that use social-psychological theory to promote compliance with low-impact recreation behavioral recommendations?)⁴. We first

However, Eagly and Chaiken (1993) proposed that attitudes included three components: belief, affect, and behavior. In other words, beliefs could be considered as a dimension of attitudes. In low-impact recreation behavior literature, attitudes are commonly operationalized as beliefs with underlying assumption that beliefs and attitudes are the same construct. In future research, researchers should better differentiate these two constructs. However, in this study we decided to merge attitudes and behavioral beliefs into the same predictor to reflect the position proposed by Eagly and Chaiken (1993) and the current state of low-impact recreation research. The same consideration was used for norms and normative beliefs, and perceived control and control beliefs.

³ This study was an initial examination of relevant social-psychological constructs that have been examined in low-impact recreation literature. We consider the unification of terminology and conceptualization a collective effort for the field and anticipate future discussions.

⁴ Four studies were initially coded as behavioral change studies since they used pre and post- tests. However, these studies evaluated a behavioral change campaign or training course that integrated multiple interventions over a long time period and they were significantly different from the rest of the interventions which were all at a more specific spatial and temporal scale (Bromley, Marion, & Hall, 2013; Daniels & Marion, 2005; Jones & Bruyere, 2004; Jones & Lowry, 2004). These four studies were excluded from the analysis for research question three.

summarized the *behavioral change studies* in terms of their study designs. We then coded the studies based on whether their interventions were developed based on theories or not, and if they were, what social psychological factors they targeted. We identified 190 behavioral change interventions targeting a variety of behaviors at different locations⁵. We coded the effectiveness of each behavioral change intervention based on the actual compliance/non-compliance percentages or ratings into three categories: 1) improved from control or pre-test; 2) not improved from control or pre-test; and 3) no control or pre-test. Effectiveness was defined by the change in behavior under the intervention as compared to the control, if any. We did not take the statistical significance information into consideration. The sample sizes of studies varied and most studies did not report power-analysis results, making it difficult to interpret non-significant results. Instead, we focused on how the intervention performed across various situations. Then we recorded the names, descriptions and justification of the interventions to develop interpretable themes. We, then, fitted a mixed effects logistic model with effectiveness as the dependent variable (0 = no positive effect and 1 = positive effect) and whether the intervention was developed based on theories as the independent variable. Which study the model was from was the random effect.

Findings

Social-Psychological Predictors

Review of the 25 *prediction model studies* identified 66 models predicting compliance/non-compliance with low-impact recreation behavioral recommendations. Among these studies, 12 used structural equation modeling, 11 used regression analysis and two used

⁵ Some studies examined the effect of the same treatment on different behaviors across locations resulting in a large total number of behavioral interventions.

path analysis⁶. We identified the use of 55 social-psychological constructs, which were conceptualized and tested as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations (Table 2.2, Table 2.3; Predictors that were examined by only one study were not included in Table 2.2 but are summarized in Appendix A). The predictor that was studied most often was attitudes toward the behavior (10 studies), followed by subjective norms (7 studies), knowledge (5 studies) and environmental worldview (5 studies, which were most often measured using the New Ecological Paradigm scale). Most of these predictors originate from social-psychological theory (Theory of Planned Behavior, Theory of Reasoned Actions, and Value-Belief-Norm theory) with some originating from theory developed within the field of environmental-psychology (e.g., place attachment) and a smaller subset originating from outdoor recreation theory itself (e.g., recreation specialization). We observed these social-psychological predictors do not always significantly predict compliance/non-compliance with low-impact recreation behavioral recommendations. For example, 17 out of 28 models found attitudes toward behaviors significantly predicted compliance/non-compliance with low-impact recreation behavioral recommendations, while 11 models did not. Among the predictors which have been hypothesized as direct effects on compliance/non-compliance with low-impact recreation behavioral recommendations in more than 10 models⁷, recreation specialization had the highest odds of being found significant (odds = 8.0) and knowledge had the lowest odds of being found significant (odds = 0.9).

⁶ These numbers do not add up to 25 because some studies used both structural equation modeling and regression analysis.

⁷ Constructs studied less often were more likely to result in “unusual” results including false significance/non-significance. We arbitrarily set a number of ten models as the criteria for inclusion in this comparison.

Predictability of Social-Psychological Models

To address RQ 2, we reviewed the proportion of observed variance in the low-impact recreation behavior measure explained by the socio-psychological predictors, reported in the 25 *prediction model studies*. Unfortunately, six studies did not report an R^2 , resulting in a total of 56 models with an R^2 reported. On average, social-psychological models explained 28.2% of the variance in compliance/non-compliance with low-impact recreation behavioral recommendations; the standard deviation was 0.184. The median R^2 reported was 23.0%, and half of the studies reported values of R^2 between 15.0% (25th quantile) and 37.95% (75th quantile). The lowest percent of explained variance was 2.0% (Oh & Ditton, 2008) and the highest percent of explained variance was 89.4% (Zhang et al., 2015).

Behavioral Change Intervention

To address RQ 3, we reviewed the 31 *behavioral change studies*. The majority of *behavioral change studies* used field-based experiments (90.3%, n=28) and attempted to test the effects of messaging on compliance/non-compliance with low-impact behavioral recommendations (74.2%, n = 23). Exceptions included three studies which used laboratory-based experiments (Duncan & Martin, 2002; Gramann, Bonifield, & Kim, 1995; Trafimow & Borrie, 1999). Eight studies tested other visitor management techniques along with messaging including: 1) the use of incentives (Clark, Hendee, & Burgess, 1972; Vander Stoep & Gramann, 2015); 2) requests for reporting depreciative behavior or environmental degradation (Oliver, Roggenbuck, Watson, & Service, 1985; Vander Stoep & Gramann, 2015); 3) commitment and pledge (Widner & Roggenbuck, 2000); 4) role modeling (Littlefair & Buckley, 2008; Wagstaff, 1988); and 5) physical environment alterations such as fencing and repainting trail blazes (Park et al., 2008; Widman, 2010). Out of the 23 studies that focused on messaging, 17 studies (87.0%)

tested the contents of the messaging, followed by four studies that tested the media or sources of the messaging; two studies tested the visual design of the messaging.

The studies reported in the *behavioral change articles* rarely directly tested the effects of social-psychological factors. Only 6 out of the 31 studies used a factorial experimental design (Bradford & McIntyre, 2005; Cialdini et al., 2006; Cohn, Hendricks, & Chavez, 2008; Gramann et al., 1995; Hendricks, Ramthun, & Chavez, 2001; Trafimow & Borrie, 1999), an established experimental design approach that enables statistical testing of the main effects and interactions among specific factors⁸. Factors tested in these studies are summarized in Table 2.4. Among the experiments using a factorial experimental design, only Cialdini et al. (2006) and Gramann and Bonfield (1995) directly tested the effects of social-psychological factors on compliance/non-compliance with low-impact recreation behavioral recommendations.

Interestingly, few studies directly applied social-psychological theories when developing behavioral change interventions. We were able to identify only nine studies that clearly reported how theories were used to develop their behavioral change interventions. Two approaches emerged from these nine studies. We refer to the first approach as the *salient belief approach* adopting the terminology used by Brown, Ham and Hughes (2010) and Hughes, Ham and Brown (2009). Based on Theory of Planned Behavior and Theory of Reasoned Action, this approach is grounded in three-phase studies to develop and test interventions. The phases consist of: 1) a belief solicitation phase using surveys or interviews to gauge individuals' beliefs about the behaviors of interest; 2) a belief selection and message development phase using expert judgments to select beliefs with maximum persuasion potential for targeted communication

⁸ Factorial experimental designs usually start with two or more factors of interest to the researchers. Each factor has different levels. The combination of factor levels across factors form treatments. For example, if there are two factors and each factor has two levels, there will be 4 treatments. This is often referred to as a 2 X 2 design with participants assigned to each treatment.

interventions; and 3) an intervention-test phase. The messages aimed to change the target beliefs. We refer to the second approach as an *integrative approach*. Rather than applying only one theory, these studies integrated multiple theories and targeted a set of social-psychological factors. An important assumption of these studies was that their messages successfully primed the targeted social-psychological factors. Most of these studies tested participants' level of attention paid to the messages or their attitudes or knowledge. Using these two approaches, the theory-based interventions targeted a total of six social-psychological factors that have been studied as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations (Table 2.5).

A total of 14 studies (45.2% of the *behavioral change studies*) did not refer to any social-psychological or recreation theories. Another three studies mentioned social-psychological theories but did not report how these theories guided their intervention development. It appears that some researchers did, in fact, draw upon an understanding of the relevant literature and common visitor management techniques, but were not explicit about how they applied theories in their studies. Instead, most of these studies directly tested visitor education practices. An example of a commonly tested technique is the comparison between regulatory and interpretative messages. Regulatory messages usually involve information regarding fines and sanctions, while interpretative messages give more information about associated behavioral consequences (e.g., Duncan & Martin, 2002). We consider these interventions as practice-based in contrast to theory-based interventions.

Despite the diversity in theory-based and practice-based interventions, most interventions (83.5%, $n = 159$) showed positive effects on their targeted behaviors, while 36 interventions found no effects. Interestingly, practice-based interventions were found to be more likely to have

positive effects on compliance with low-impact recreation behavior than were theory-based approaches ($\beta = 1.3$, t -value = 2.74, p -value = 0.01).

Discussion

We identified a list of 55 social-psychological predictors of compliance/non-compliance with low-impact recreation behavioral recommendations. Social-psychological constructs from Theory of Planned Behavior, Theory of Reasoned Action, Values-Beliefs-Norm theory, place attachment and recreation specialization theories have been studied more often than others such as values, past behaviors, and conceptions of recreation experience. Whether or not individual social-psychological constructs were significantly correlated with low-impact recreation behaviors were inconsistent. On average, the models employed to explain compliance/non-compliance with low-impact recreation behavioral recommendations accounted for only 28.2% of variance in measures of low-impact recreation behavior. Among these 55 social-psychological constructs, six were used to guide theory-based behavior change interventions including attitudes toward behaviors, awareness of consequences, ascription of responsibility, personal norms, subjective norms and knowledge. Half the *behavioral change studies* did not explicitly develop their interventions based on existing theories. These studies appeared to be based on practice and/or an intuitive understanding of theories. Most (70.5%) of the behavior change interventions utilized messaging, a common communication tool used among outdoor educators and interpreters. Generally, the *behavioral change studies* showed messaging was effective in inducing compliance with low-impact recreation behavioral recommendations. Practice-based interventions were more likely to be associated with increased compliance than were theory-based interventions.

Complex Human Behavior

The first purpose of this review was to advance the conceptualization of why recreationists' do or do not comply with low-impact recreation behavioral recommendations. We identified a large number of social-psychological constructs relevant to low-impact recreation behavior and summarized the statistical significance of these social-psychological predictors. We did not assess the magnitudes or directionality of estimated effects. Additionally, we did not account for the diversity in how individual studies operationalized the social-psychological constructs, how they collected their data, or which behavior they examined in what contexts. Our results revealed that while some social-psychological constructs such as 'recreation specialization' were consistent and positive predictors of compliance with low-impact recreation behavioral recommendations, most constructs exhibited no consistent relationship with compliance or non-compliance. This finding suggests compliance with low-impact recreation behavioral recommendations is a complex and, most likely, highly context-dependent phenomenon.

It is striking that, on average, the social-psychological models explained only 28.2% of the variance in compliance with low-impact recreation behavioral recommendations. Research design is one possible explanation for the moderate predictive power of these models. We did not evaluate or compare the quality of each *prediction model study*. A strong research design generally increases the validity of models. The complexity of models examined in a study should not compromise the quality of the research design in terms of clearly stated assumptions and scope, well-defined concepts, carefully selected operationalizations, and rigorous and transparent data collection and analysis methods. It is likely that past designs have omitted one or more important variables related to compliance/non-compliance. Contextual factors are a glaring

omission from most previous empirical work. Terborg (1981) argued that researchers should adopt the perspective of interactional psychology that emphasizes continuous, multidirectional interaction between individual factors and situational factors to study individual behavior, and focus more on individual factors that might be expected to mediate the effects of situational factors and vice versa. Similarly, Schultz and Kaiser (2012) suggested pro-environmental behavior should be studied as an interplay between personal factors including social-psychological factors and contextual factors such as physical environment, incentives, and policies. The perspective of interactional psychology also applies to low-impact recreation behavior research. Guo, Smith, Leung, Seekamp, and Moore (2015) in their experimental study of off-trail hiking behavior found contextual factors (i.e., the type and extent of trail degradation) significantly predicted individuals' intent to comply with low-impact hiking behavioral recommendations (e.g., hiking down the middle of a wet or eroded trail).

Is a large, complex and multi-dimensional model with all possible social-psychological and contextual factors the best way to conceptualize compliance/non-compliance to low-impact recreation behavioral recommendations? This question highlights a fundamental challenge in the modeling approach to study low-impact recreation behavior. Current modeling approaches attempt to parcel out personal and environmental factors relevant to the behavior and then re-connect the factors, often through hypothesized linear relationships. Models built through this process will always require more predictors to account for the inherent complexity of the behavioral phenomenon. By adding more predictors, models inevitably lose their parsimony and become more difficult to test in single studies (Diefendorff & Chandler, 2011). For example, increasing the number of predictors also raises the risk of collinearity among predictors, which may lead to unstable estimation of coefficients and significance (Faraway, 2015). More

importantly, the greater the number of predictors examined, the more difficult it is to make meaningful managerial recommendations. The number of relevant social-psychological constructs may be enormous, but the resources available to address the constructs are always limited. A large number of relevant predictors also means numerous potential interactions, which may have contributed to the mixed findings in past low-impact recreation research.

Advancing the modeling approach to low-impact recreation behavior requires more effort to synthesize findings and build an integrated conceptual framework. Besides traditional reviews to summarize findings and literature reviews focusing on specific research questions, more statistical synthesis efforts are needed. One well-developed technique is meta-analysis that synthesizes model findings from multiple datasets in a systematic way to reach final conclusions (Shelby & Vaske, 2008). A meta-analysis of low-impact recreation studies should at least achieve two goals: 1) to identify key factors under unique circumstances (e.g., settings, populations, activities); and 2) to specify how constructs studied in individual studies relate to each other in a cohesive conceptual framework. To achieve these goals, low-impact recreation researchers need to improve the transparency of individual studies in terms of how they collected data, conducted analysis, and what statistics to report. There is still inconsistency in how to report methods and findings (e.g., standard deviation versus standard error); this is worthy of future attention from outdoor recreation researchers. Open data sharing, another important condition for meta-analysis, is uncommon in outdoor recreation research. The synthesis of visitor use studies including database compilation, maintenance, analysis, and sharing is worthy of a well-funded research program.

There are approaches other than fitting prediction models for examining complex human behavior in context-dependent situations. One approach is to use qualitative or mixed methods.

An example is a project on petrified wood theft at Petrified Forest National Park. Widner and Roggenbuck (2000) reported quantitative results on the effects of treatment in their field experiments, but this was followed by a qualitative examination of individuals' responses to the interventions and why they engaged in fossil theft (Ward & Roggenbuck, 2003). Another approach is to examine low-impact recreation behavior at the group level focusing on individual differences and visitor classification. Some social-psychological predictors might play more fundamental roles in explaining individual differences such as values, which are also worthy of future study (Schwartz, 1992, 1994, Fulton, Manfredo, & Lipscomb, 1996; Homer & Kahle, 1988; Vaske, Maureen, Donnelly, & Dani, 2001). An examination of individual differences in compliance with low-impact recreation behavior recommendations may inform what and how social-psychological constructs influence individuals in the same contexts. For example, Diedrich, Terrados, Arroyo, and Balaguer (2013) used classification tree analysis (also called decision tree analysis) to group boaters at a coastal area based on their attitudes and beliefs toward compliance with a low-impact boating recommendations. Compared to traditional cluster analysis, this statistical technique is able to identify key constructs that account for personal differences through classification.

Theory and Effective Behavioral Change Interventions

The second purpose of this study was to identify clear conceptual pathways from understanding of relevant socio-psychological predictors to behavioral change interventions. We found only a handful of social-psychological constructs were used to guide the development of behavioral change interventions (6 out of 55). Half of the interventions were practice-based rather than theory-based. It is worth noting we did not find any objective criteria to determine which interventions would be considered theory-based as opposed to practice-based. The

challenges for such objective criteria are obvious. The extent to which researchers applied theories in designing behavioral change interventions often falls on a continuum rather than in discrete categories. The broad definition of “theory” sometimes added difficulty to objectively distinguishing the extent to which behavioral change interventions were theory-driven. When we coded the interventions, we found very few studies had been designed explicitly to test theory (Cialdini et al., 2006; Trafimow & Borrie, 1999). More often, the interventions we coded as ‘theory-based’ explicitly stated how the intervention was targeted at specific social-psychological factors (e.g., social norms) believed to directly influence a specific low-impact recreation behavior. How practice-based interventions were developed was less clear. As Hughes et al. (2009) commented, “although the general approach was based on theory, it appears that the message content was based on the experience and ideas of the authors and park managers”(p. 39). Given the field of outdoor recreation research is generally application-oriented, it is not surprising that researchers design interventions from common practices encountered in the field (e.g., Hendricks et al., 2001; Marion & Reid, 2007).

Interestingly, we found practice-based interventions achieved compliance with low-impact recreation behavioral recommendations more often than theory-based interventions did. We did not intend to create a false dichotomy between theory and practice (Henderson, Presley, & Bialeschki, 2004). However, our findings may be an indicator that current approaches for using theory to develop behavioral change interventions are sometimes insufficient. Henderson (1994) argued that without theory in research, researchers might continue to uncover pieces of a puzzle rather than gain the entire picture of how those pieces relate to each other and to the bigger picture of reality. Hughes et al. (2009) suggested explaining the successes or shortcomings of communications as management tools can be difficult in the absence of

adequately substantiated theory. Moreover, the mixed findings about the effectiveness of practice-based interventions (e.g., sanction versus interpretive signs, invoking fear versus moral appeals, etc.), as Widner and Roggenbuck (1999) summarized, suggest a theoretical approach is needed to both explain inconsistency and build connections between characteristics of successful interventions and characteristics of contexts. The question about how to clarify the theoretical pathway from theories to behavioral change interventions is relevant to researchers and natural resource managers and warrants more attention.

A logic exercise regarding why practice-based interventions induced compliance more often than theory-based interventions may shed light on how to improve theory-based interventions. Practice-based interventions were developed based on experts' insights and experiences; this represents an intuitive approach to problem solving as opposed to a deductive and entirely analytic approach. Practice-based interventions may be more attuned to what is happening in the field (i.e., contextual factors) and what is truly driving individuals' behaviors (i.e., which social-psychological factors matter the most). The theory-based interventions we reviewed tended to use a particular theory or a small number of theories that represent simplified understandings of reality. Researchers have called for the use of multiple theoretical viewpoints to develop interventions (Vande Kamp et al. 1994; Christensen & Dustin, 1989; Knopf & Dustin, 1992; Johnson & Vande Kamp, 1994; Widner & Roggenbuck, 1999), but based on our findings, this recommendation does not appear to have been heeded. One challenge affecting this slow transition may be how to integrate multiple theories into specific interventions. A temporally-oriented multi-theory approach to low-impact recreation behavior research may assist in efforts to advance behavioral change studies integrating theories *and* practice.

Dalal and Hulin (2008) conceptualized human behavior as a stream of discrete behaviors. In such continuous streams of behaviors, preceding behaviors along with the individual and contextual factors surrounding them, “steer” future behaviors. For each steering decision, only a limited number of individual and contextual factors may be salient. *When* an individual factor or contextual factor shows its effects on compliance with low-impact recreation behavioral recommendations will vary depending on the characteristics of the behavior itself, the actors, and the contexts. The key role of a temporal-oriented multi-theoretical approach to *behavioral change studies* is to organize the growing number of relevant social-psychological factors in terms of *when* they show their effects in specific contexts. The long-standing process-models of persuasion from social-psychology provide frameworks to conceptualize how recreationists respond to education efforts and how each social-psychological factor influences individual responses.

Specifically, McGuire’s (1968) paradigm conceptualized the process individuals go through as they receive and act upon a persuasive message. This process includes six steps: 1) presentation; 2) attention; 3) comprehension; 4) yielding; 5) retention; and 6) behavior. Each of the steps could be considered as a behavioral decision. Do viewers pay attention to the message or not? If they paid attention, do they understand the contents of the message or not? If they paid attention and understood the message, do they agree with the message or not? A chain of questions could be asked along this line of logic. What researchers should care about is what and how social-psychological factors “steer” each behavioral decision, and collectively, at which behavioral decision each social-psychological factor is influential. For example, for the factor of memory to influence the effectiveness of an educational message, other social-psychological factors such as attention knowledge and attitudes need first “steer” the behavior toward the

behavioral decision of retention. Researchers who attempt to study retention need to control for important antecedent factors (e.g., attention, knowledge, attitudes); otherwise, it will be difficult to determine whether the observed behavior change (if any) was due to the effects of memory or other preceding factors. Using the temporally-oriented and multi-theoretical approach, theory-based behavioral change interventions are more likely to fully account for the complexity of compliance with low-impact recreation behavioral recommendations. Moreover, researchers using this approach will be able to provide a systematic and testable account of the complexity of compliance/non-compliance with low-impact recreation behavior, which is an advantage compared to practice-based interventions.

Limitation, Future Studies and Implications

As with all research, this review had limitations. We focused our review on *prediction model* and *behavioral change studies* and did not fully summarize the contribution of *comparison and evaluation studies*, which are also worth rigorous reviews in the future. Neither did we conduct a statistical review of previous empirical research. Future reviews should use statistical review techniques such as meta-analysis to examine the effects of individual social-psychological factors.

This review relied heavily on theories and perspectives from social-psychology with some applications from environmental-psychology. Although this perspective is commonly used in the literature, there are theories from other disciplines such as Barker's (1968) behavior settings theory and Gibson's (1977) theory of affordances from ecology; they suggest behavior changes can be achieved through altering the physical environment. We recommend that future reviews include these and other broader perspectives. It is quite possible that a better understanding of the complexity of the human mind combined with a better understanding of

overt behaviors and the degree desirable behaviors can be elicited through environmental and policy interventions will yield more effective theoretical and practical results.

We set out to examine which social-psychological factors have been evaluated as predictors or factors of compliance with low-impact recreation behavioral recommendations. We identified some limitations of existing theory-based *prediction model studies* and *behavioral change studies*. From a theory-development perspective, such self-reflection and evaluation of what and how theories have been used in low-impact recreation research is necessary. Through the review, we identified a variety of ways in which future research can develop a more robust understanding of how and why individuals do or do not comply with low-impact recreation behavioral recommendations. For example, we highlighted the need to undertake synthesis-type studies (e.g., meta-analysis) in outdoor-recreation research. We suggest the field improves transparency and standards in data collection and reporting and promotes open data sharing. We compared practice-based and theory-based behavior change interventions and proposed a temporally-oriented and multi-theory approach to systematically examining the complexity of visitor behavior. This review is an important step toward developing a more complete and meaningful conceptual framework for low-impact recreation behavior research.

Our review was not primarily directed to immediate direct implications for natural resource management. However, we used relevance to natural resource management as an underlining criterion to assess previous research. It seems evident from our findings and discussion regarding theory-based versus practice-based interventions that altering human behavior is both an art and a science. The results suggest the need for future research to be informed by practical *and* theoretical knowledge and for behavioral change interventions to be guided by both intuitive *and* analytical approaches to problem solving.

References

- Alfano, S. S., & Arthur, W. M. (1976). *Vandalism and outdoor recreation: symposium proceedings Pacific Southwest*. Berkeley, CA.
- Barker, R. G. (1968) *Ecological psychology: concepts and methods for studying the environment of human behavior*. Stanford, Calif.: Stanford University Press, 1968.
- Bradford, L., & McIntyre, N. (2005). Off the beaten track : messages as a means of reducing social trail use at St . Lawrence Islands National Park. In *2005 Parks Recreation Forum of Ontario*.
- Bromley, M., Marion, J. L., & Hall, T. (2013). Training to teach Leave No Trace : efficacy of Master Educator Courses. *Journal of Park and Recreation Administration*, 31(4), 62–78.
- Brown, T. J., Ham, S. H., & Hughes, M. (2010). Picking up litter: an application of theory-based communication to influence tourist behaviour in protected areas. *Journal of Sustainable Tourism*, 18(7), 879–900. <http://doi.org/10.1080/09669581003721281>
- Burn, S. M., & Winter, P. L. (2007). *Environmental intervention handbook for resource managers: a tool for proenvironmental behavior change 2nd Edition*. Riverside, CA.
- Retrieved from
http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1029&context=psycd_fac
- Cheng, T.-M., & Wu, H. C. (2015). How do environmental knowledge, environmental sensitivity, and place attachment affect environmentally responsible behavior? An integrated approach for sustainable island tourism. *Journal of Sustainable Tourism*, 23(4), 557–576. <http://doi.org/10.1080/09669582.2014.965177>
- Christensen, H. H., Johnson, D. R., & Brookes, M. H. (Eds.). (1992). *Vandalism : research , prevention and social policy*. Porland, OR.

- Cialdini, R. B., Demaine, L. J., Sagarin, B. J., Barrett, D. W., Rhoads, K., & Winter, P. L. (2006). Managing social norms for persuasive impact. *Social Influence*, 1(1), 3–15. <http://doi.org/10.1080/15534510500181459>
- Clark, R. N., Hendee, J. C., & Burgess, R. L. (1972). The experimental control of littering. *The Journal of Environmental Education*, 4(2), 22–28.
- Cohn, S. S., Hendricks, W. W., & Chavez, D. J. (2008). *Visitor compliance with fire restrictions : an observational study using verbal messages and symbolic signage*.
- Cooper, H. M. (1988) Organizing knowledge syntheses: a taxonomy of literature review. *Knowledge in society*, 1(1): 104-126.
- D'Antonio, A., Monz, C., Newman, P., Lawson, S., & Taff, D. (2012). The effects of local ecological knowledge, minimum-impact knowledge, and prior experience on visitor perceptions of the ecological impacts of backcountry recreation. *Environmental Management*, 50(4), 542–554. <http://doi.org/10.1007/s00267-012-9910-x>
- Dalal, R. S., & Hulin, C. L. (2008). Motivation for what? a multivariate dynamic perspective of the criterion. In *Work motivation: past present, and future* (pp. 63–100). New York: Taylor & Francis.
- Daniels, M., & Marion, J. L. (2005). Communicating leave no trace ethics and practices: efficacy of two-day trainer courses. *Journal of Park and Recreation Administration*, 23(1), 1–19.
- Diefendorff, J. M., & Chandler, M. M. (2011). Motivating employees. In S. Zedeck (Ed.), *Handbook of Industrial and Organizational Psychology, Vol 3: Maintaining, expanding, and contracting the organization. APA Handbooks in Psychology* (pp. 65–135). Washington, DC: American Psychological Association.
- Doucette, J. E., & Cole, D. N. (1993). *Wilderness visitor education: information about*

- alternative techniques* (Vol. General Te).
- Duncan, B. Y. G. S., & Martin, S. R. (2002). Comparing the effectiveness of interpretive and sanction messages for influencing wilderness visitors' intended behavior. *International Journal of Wilderness*, 8(2), 20–25.
- Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Orlando, FL: Harcourt Brace & Company.
- Faraway, J. J. (2015). Problems with the predictors. In *Linear Models with R* (2nd ed., pp. 99–106). New York: CRC Press.
- Gibson, J. J. (1977). The theory of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: toward an ecological psychology* (pp. 67–82). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Gramann, J., Bonifield, R., & Kim, Y.-G. (1995). Effect of personality and situational factors on intentions to obey rules in outdoor recreation areas. *Journal of Leisure Research*. Retrieved from <http://www.questia.com/googleScholar.qst?docId=5000369730>
- Guo, T., Smith, J. W., Leung, Y.-F., Seekamp, E., & Moore, R. L. (2015). Determinants of Responsible Hiking Behavior: Results from a Stated Choice Experiment. *Environmental Management*, 56(3), 765–776. <http://doi.org/10.1007/s00267-015-0513-1>
- Halpenny, E. a. (2010). Pro-environmental behaviours and park visitors: The effect of place attachment. *Journal of Environmental Psychology*, 30(4), 409–421.
<http://doi.org/10.1016/j.jenvp.2010.04.006>
- Ham, S. H., & Krumpe, E. E. (1996). Identifying audiences and messages for nonformal environmental education -A theoretical framework for interpreters. *Journal of Interpretation Research*, 1(1), 11–23.

- Henderson, K. A. (1994). Theory application and development in recreation, parks, and leisure research. *Journal of Park and Recreation Administration*, 12(1), 51–64.
- Henderson, K. A., Presley, J., & Bialeschki, M. D. (2004). Theory in recreation and leisure research: reflections from the editors. *Leisure Sciences*, 26(4), 411–425.
<http://doi.org/10.1080/01490400490502471>
- Hendricks, W. W., Ramthun, R. H., & Chavez, D. J. (2001). The effects of persuasive message source and content on mountain bicyclists' adherence to trail etiquette guidelines. *Journal of Park and Recreation Administration*, 19(3), 38–61. Retrieved from
<http://www.cabdirect.org/abstracts/20013156870.html>
- Hughes, M., Ham, S. H., & Brown, T. (2009). Influencing park visitor behavior : a belief-based approach. *Journal of Park and Recreation Administration*, 27(4), 38–53.
- Jackson, G. B. (1980) Methods for integrative review. *Review of Educational Research*, 50 (3): 438-460.
- Jones, M. K., & Bruyere, B. L. (2004). Frontcountry Leave No Trace Program Evaluation, City of Boulder Open Space and Mountain Parks. In *International Symposium on Society and Resource Management* (Vol. 1, pp. 1–18). Keystone, Colorado.
<http://doi.org/10.1017/CBO9781107415324.004>
- Jones, M. K., & Lowry, R. (2004). Effectiveness of trailhead education on cleaning up dog litter. In *International Sy* (Vol. 53, pp. 1689–1699). Keystone, Colorado.
<http://doi.org/10.1017/CBO9781107415324.004>
- Kim, A. K. (2012). Determinants of tourist behaviour in coastal environmental protection. *Tourism Geographies*, 14(1), 26–49. <http://doi.org/10.1080/14616688.2011.597774>
- Knopf, R. C., & Andereck, K. L. (2004). Managing depreciative behavior in natural settings. In

- M. J. Manfredo, J. J. Vaske, B. L. Bruyere, D. R. Field, & P. J. Brown (Eds.), *Society and natural resources: a summary of knowledge prepared for the 10th International Symposium on Society and Resource Management*. Jefferson, MO: Modern Litho.
- Kollmuss, A., & Agyeman, J. (2002). Mind the Gap : why do people act environmentally and what are the barriers to, 8(3). <http://doi.org/10.1080/1350462022014540>
- Lee, T. H., & Jan, F. H. (2015). The effects of recreation experience, environmental attitude, and biospheric value on the environmentally responsible behavior of nature-based tourists. *Environmental Management*, 56(1), 193–208. <http://doi.org/10.1007/s00267-015-0488-y>
- Littlefair, C., & Buckley, R. (2008). Interpretation reduces ecological impacts of visitors to world heritage site. *Ambio: A Journal of the Human Environment*, 37(5), 338–341. <http://doi.org/10.1579/07-R-393.1>
- Lucas, R. (1981). *Redistributing wilderness use through information supplied to visitors*. Ogden, UT.
- Manning, R. E. (2003). Emerging principles for using information/education in wilderness management. *International Journal of Wilderness*, 9(1), 20–27. Retrieved from <http://issuu.com/ijwilderness/docs/vol-09.no-1.apr-03/21?e=1888065/6763369#>
- Manning, R. E. (2011). Managing outdoor recreation: alternative management practices. In *Studies in Outdoor Recreation: Search and Research for Satisfaction* (3rd Eds., pp. 273–321). Corvallis, OR: Oregon State University Press.
- Marion, J. L., Dvorak, R. G., & Manning, R. E. (2008). Wildlife feeding in parks: methods for monitoring the effectiveness of educational interventions and wildlife food attraction behaviors. *Human Dimensions of Wildlife*, 13(January 2015), 429–442. <http://doi.org/10.1080/10871200802270158>

- Marion, J. L., Leung, Y., Eagleston, H., & Burroughs, K. (2016). A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry*, 114(May), 1–17. <http://doi.org/10.5849/jof.15-498>
- Marion, J. L., & Reid, S. E. (2007). Minimising visitor impacts to protected areas: the efficacy of low impact education programmes. *Journal of Sustainable Tourism*, 15(1), 5–27. <http://doi.org/10.2167/jost593.0>
- Oh, C.-O., & Ditton, R. B. (2008). Using recreation specialization to understand conservation support. *Journal of Leisure Research*, 40(4), 556–573. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2008-17470-004&site=ehost-live&scope=site>
- Oliver, S. S., Roggenbuck, J. W., Watson, A. E., & Service, F. (1985). Education to reduce impacts in forest campgrounds. *Journal of Forestry*, 234–236.
- Park, L. O., Manning, R. E., Marion, J. L., Lawson, S. R., & Jacobi, C. (2008). Managing visitor impacts in parks: A multi-method study of the effectiveness of alternative management practices. *Journal of Park and Recreation Administration*, 26(1), 97–121.
- Plemmons, S. A., & Weiss, H. M. (2013). Goals and affect. In E. A. Locke & G. P. Latham (Eds.), *New Developments in Goal Setting and Task Performance* (pp. 117–132). New York, NY: Routledge.
- Schultz, P. W., & Kaiser, F. G. (2012). Promoting pro-environmental behavior. In S. D. Clayton (Ed.), *The Oxford Handbook of Environmental and Conservation Psychology* (pp. 556–580). New York, NY: Oxford University Press.
- Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, 56(3), 407–424. <http://doi.org/10.1111/0022-4537.00175>

- Taff, D., Newman, P., Bright, A., & Vagias, W. (2011). Day-user beliefs regarding Leave No Trace in Rocky Mountain National Park. *Journal of Outdoor Recreation, Education, and Leadership*, 3(2), 112–115. <http://doi.org/10.7768/1948-5123.1110>
- Terborg, J. R. (1981). Interactional psychology and research on human behavior in organizations. *The Academy of Management Review*, 6(4), 569–576. <http://doi.org/10.5465/AMR.1981.4285691>
- Trafimow, D., & Borrie, W. T. (1999). Influencing future behavior by priming past behavior: a test in the context of Petrified Forest National Park. *Leisure Sciences*, 21(February), 31–42. <http://doi.org/10.1080/014904099273273>
- Van Riper, C. J., & Kyle, G. T. (2014). Understanding the internal processes of behavioral engagement in a national park: A latent variable path analysis of the value-belief-norm theory. *Journal of Environmental Psychology*, 38, 288–297. <http://doi.org/10.1016/j.jenvp.2014.03.002>
- Vande Kamp, M. E., Johnson, D. R., & Sewaringen, T. C. (1994). *Deterring minor acts of noncompliance a literature review*. Seattle, WA.
- Vander Stoep, G. A., & Gramann, J. H. (2015). The effect of verbal appeals and incentives on depreciative behavior among youthful park visitors. *Statewide Agricultural Land Use Baseline 2015*, 19(2), 69–83. <http://doi.org/10.1017/CBO9781107415324.004>
- Vaske, J. J., & Donnelly, M. P. (1999). A value-attitude-behavior model predicting wildland preservation voting intentions. *Society & Natural Resources*, 12(6), 523–537. <http://doi.org/10.1080/089419299279425>
- Vaske, J. J., & Kobrin, K. C. (2001). Place attachment and environmentally responsible behavior. *The Journal of Environmental Education*, 32(4), 16–21.

<http://doi.org/10.1080/00958960109598658>

Wagstaff, M. (1988). The evaluation of litter behavior modification in a river environment. *The Journal of Environmental Education*, 20(1), 39–44.

Ward, C. W., & Roggenbuck, J. W. (2003). Understanding park visitors' response to interventions to reduce petrified wood theft. *Journal of Interpretation Research*, (September), 2009–2009.

Weston, M. A., Schlacher, T. A., & Lynn, D. (2014). Pro-environmental beach driving is uncommon and ineffective in reducing disturbance to beach-dwelling birds. *Environmental Management*, 53(5), 999–1004. <http://doi.org/10.1007/s00267-014-0256-4>

Widman, C. G. (2010). *Discouraging off-Trail hiking to protect park resources : evaluating management efficacy and natural recovery*. Virginia Polytechnic Institute and State University.

Widner, C. J., & Roggenbuck, J. W. (2000). Reducing theft of petrified wood at Petrified Forest National Park. *Journal of Interpretation Research*, 5(1), 1–18.

Wynveen, C. J., Connally, W. D., & Kyle, G. T. (2013). Pro-environmental behavior in Marine Protected Areas : the cases of the Great Barrier Reef Marine Park and the Florida Keys National Marine Sanctuary. *Journal of Park and Recreation Administration*, 31(2), 28–49.

Zhang, Y., Zhang, J., Zhang, H.-L., Cheng, S., Guo, Y., Ma, J., & Jing-rong, S. (2015). The impact of the cognition of landscape experience on tourist environmental conservation behaviors. *Journal of Mountain Science*, 12(2), 501–517.

Table 2. 1. Keywords used in article search

(recreation OR park OR protected areas OR sustainable tourism)
AND (responsible behavior)
OR depreciative
OR minimum impact
OR pro-environmental OR proenvironmental
OR non-compliant
OR compliant

Table 2. 2. Socio-psychological factors conceptualized as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations in past studies.

Predictor	Number of articles	Number of models	As direct effect		As indirect effect	
			S	N.S.	S.	N.S.
Attitudes toward the behavior	10	28	17	11		
Subjective norms	7	12	7	5		
Knowledge	5	20	9	10	1	
Environmental worldview	5	8	4	2	2	
Recreation specialization	4	10	8	1	1	
Perceived control	3	8	2	6		
Ascription of responsibility	3	4	1		3	
Place attachment	3	5	3		2	
Perceived difficulty	2	14	11	3		
Awareness of consequences	2	3			3	
Personal norm	2	3	3			
Place dependence	2	3	1	2		
Place identity	2	3	1	2		

S: Significant coefficient. N.S. non-significant coefficient

Table 2. 3. Social psychological predictors examined in previous research

Previous Studies	TPB					VBN			Place Attachment				
	AT	KN	SN	PC	PD	EW	AC	AR	PN	PA	PA-PD	PA-PI	RS
Chandool 1997	√		√										
Alessa, Bennett, Kliskey 2003		√							√				
Aipanjiguly, Jacobson, Flamm 2003	√		√										
Thapa, Graefe, and Meyer 2005			√										√
Thapa, Graefe, and Meyer 2006													√
Jett 2007	√		√										√
Oh and Ditton 2008													√
Martin and McCurdy 2009	√		√										
Halpenny 2010									√		√		
Kim 2012	√												
Ong and Musa 2012	√						√						
Serenari, Leung, Attarian, and Frank 2012	√		√	√									
Lawhon 2013	√	√				√							
Ramikissoon, Smith, and Weiler 2013													√
Ramikissoon, Smith and Weiler 2013												√	√
Wynveen, Connaly, and Kyle 2013							√	√	√	√	√		
Vagias, Powell, Moore, and Wright 2014	√	√	√	√	√								
van Riper and Kyle 2014							√	√	√	√			
Cheng and Wu 2015		√									√		
Lee and Jan 2015							√						
Lee, Jan, Huang 2015													
Goh 2015	√		√	√		√							

TPB: Theory of Planned Behavior; VBN: Value-Belief-Norm Theory; AT: Attitudes toward the Behavior; KN: Knowledge; SN: Subjective Norm; PC: Perceived Control; PD: Perceived Difficulty; EW: Environmental Worldview; AC: Awareness of Consequences; AR: Ascription of Responsibility; PN: Personal Norm; PA: Place Attachment; PA-PD: Place Dependence; PA-PI: Place Identity; PS: Place Satisfaction

Table 2.4. Socio-psychological factors tested using factorial environmental design.

Tested Factors	Level of Factors	Previous Studies
Location of message	1) Close to social trails; 2) at an information booth away from the social trails	Bradford and McIntyre 2005
Contents of the message	1) Attributional message, 2) simple message, 3) species-at-risk message 1) Awareness of consequences, 2 social responsibility	Bradford and McIntyre 2007 Gramann and Bonifield 1995
Source of the message	1) Signs, 2) verbal messages 1) Volunteer hiker, 2) biker, 3) uniformed hiker	Cohn et al. 2008 Hendricks et al. 2001
Types of appeals	1) Fear appeals, 2) moral appeals	Hendricks et al. 2001
Types of normative information	1) Descriptive norm, 2) injunctive norms	Cialdini et al. 2006
Aspects of priming past behaviors	1) Person, 2) actions, 3) imagine	Trafimow and Borrie 1999

Table 2.5. Socio-psychological factors targeted in theory-based behavioral change studies.

Constructs Examined	Number of Articles	Previous Studies
Attitudes toward the behavior	6	Widner and Roggenbuck 2000; Robbins 2005; Reigner and Lawson 2009; Kidd et al. 2015; Brown et al. 2010; Hughes et al. 2009
Ascription of Responsibility	3	Vander Stoep and Gramann 1987; Hockett 2000; Widner and Roggenbuck 2000; Reigner and Lawson 2009
Awareness of Consequences	3	Vander Stoep and Gramann 1987; Hockett 2000; Widner and Roggenbuck 2000
Personal norms	2	Widner and Roggenbuck 2000; Cialdini et al. 2006
Subjective norms	1	Cialdini et al. 2006
Knowledge	1	Robins 2005

CHAPTER 3: THE INFLUENCE OF BASIC VALUES ON COMPLIANCE WITH LOW-IMPACT RECREATION BEHAVIORAL RECOMMENDATIONS

Abstract

We examined how outdoor recreationists' values relate to compliance with low-impact recreation behavioral recommendations using Schwartz's value theory and cognitive hierarchy theory. We tested hypotheses regarding correlations between distinct value types and compliance with low-impact recreation behavioral recommendations and also examined competing models in which values either directly influence behavioral compliance or are mediated by recreationists' attitudes towards the low-impact behaviors. We collected data using an on-line survey, which measured values, attitudes towards the specific and general low-impact behaviors and attitudes towards the recreation setting. Analyses of responses obtained from 1,209 Appalachian Trail hikers revealed compliance with specific low-impact recreation behavioral recommendations to be significantly correlated with distinct types of values. The value type of *conformity-rules* was significantly correlated with compliance with most of the low-impact recreation behavioral recommendations. Our analysis also revealed simple value-attitudes-behavior fully mediated models (i.e., values → attitude towards behavior → behavioral compliance) fit the data better than the alternative models.

Keywords: low-impact recreation behavior; values; mediation models, Appalachian Trail

Introduction

Natural resource managers are tasked with reducing the disturbances on the environment caused by recreationists' behaviors. These disturbances include vegetation trampling, soil compaction, direct and indirect impacts to wildlife, and many more (Marion, Leung, Eagleston, & Burroughs, 2016). Social science research plays an important role in helping natural resource managers understand why individuals do or do not comply with low-impact recreation behavioral recommendations and what managerial efforts are most effective at influencing recreationists' behavior (Park, Manning, Marion, Lawson, & Jacobi, 2008; Vande Kamp, Johnson, & Sewaringen, 1994). Social science research has applied a wide variety of theories to the area of low-impact outdoor recreation behavior. These theories include: the Theory of Reasoned Action (TRA)/Theory of Planned Behavior (TPB); Value-Belief-Norm (VBN) Theory; the Theory of Moral Development/Reasoning; as well as theories about place attachment and recreation specialization (details see the second chapter of this dissertation). Through these efforts, social scientists have been able to identify key social-psychological factors including attitudes toward low-impact recreation behavior, knowledge, subjective norms, and personal norms that influence compliance with low-impact recreation behavioral recommendations (Lawhon, 2013; Vagias et al., 2014; Wynveen, Connally, & Kyle, 2013). Researchers are beginning to develop a solid body of knowledge on the topic of low-impact recreation behavior; however, there are important opportunities to advance this line of research.

Compared to the social-psychological factors commonly studied within the context of low-impact recreation behavior (e.g., attitudes toward the behavior, knowledge), individuals' values are rarely examined. This is surprising given the central role that values have played in the broader literature related to the human dimensions of natural resource management. Among

the research that has directly assessed the role of values relative to compliance with low-impact recreation behavior, Van Riper and Kyle (2014) found values influenced park-specific pro-environmental behaviors such as properly disposing of waste. Similarly, Lee and Jan (2015) found biospheric values (i.e., individuals' assessments of environmental phenomena based on costs and benefits to the ecosystem) were significantly related to site-specific environmentally-responsible behavior such as leaving the place as clean as it was originally after a picnic and telling companions not to feed the animals. Additionally, Vaske and Donnelly (1999) as well as Jacobs, Vaske, and Sijtsma (2014) found bio-centric and anthropocentric value orientations affected individuals' support for natural resource management policies (e.g., voting behaviors related to wildland preservation). Pro-environmental behavior studies also revealed the more strongly individuals hold pro-social, altruistic, or biospheric values the more likely they are to engage in pro-environment behavior (de Groot & Steg, 2009; Steg & Vlek, 2009). These empirical studies highlight the utility of values-oriented research for natural resource managers to better understand their visitors.

In this research, we utilized two value-related theories, Schwartz's value theory and the cognitive hierarchy theory as the theoretical foundation to explore the relationships between individuals' values and their compliance with low-impact recreation behavioral recommendations. These theories have rarely been tested in the context of low-impact recreation behavior but have played a central role in basic social-psychological research on values. Schwartz (1994, 1992) defined a value as a belief pertaining to desirable end states or modes of conduct that transcends specific situations and guides selection or evaluation of behavior, people, and events. He and his colleagues proposed that individuals hold multiple values that are organized into a system and that these value systems relate to individual behaviors. Only a small

portion of Schwartz' value systems (i.e., biospheric, altruistic, and egoistic values from Van Riper and Kyle, 2014 and Lee and Jan, 2015) has been examined in the context of low impact recreation behavior, leaving opportunities for systematic and comprehensive investigations of how values relate with compliance with low-impact recreation behavior. The cognitive hierarchy theory offers another conceptual model to understand how values influence behaviors. The cognitive hierarchy theory suggests there are conceptual paths from values to specific behaviors through attitudes (Fulton, Manfredo, & Lipscomb, 1996; Homer & Kahle, 1988; J. Vaske, Maureen, Donnelly, & Dani, 2001). Attitudes, particularly attitudes towards the behavior, are introduced as a key variable that mediates the relationship between values and behaviors. Attitudes themselves, have been extensively examined as predictors of compliance with low-impact recreation behavioral recommendations (See Chapter Two of this dissertation). The values → attitudes → behavior mediation model suggested by the cognitive hierarchy theory has been widely tested, particularly in human-wildlife interaction studies (Manfredo, Teel, & Henry, 2009; Perry-Hill et al., 2014; Sijtsma, Vaske, & Jacobs, 2012), but not in low-impact recreation behavior research.

We started with a review of the value system and then propose two propositions regarding if, and how, values relate to compliance with low-impact recreation behavioral recommendations. The propositions were based on Schwartz's value theory and the cognitive hierarchy theory. We tested these two propositions using data collected from Appalachian Trail long distance hikers regarding their basic values and compliance with well-established low-impact hiking behavioral recommendations.

Value System

Schwartz's value theory is one of the most well tested conceptualizations of individual values (Bardi & Schwartz, 2003; Steg, Perlaviciute, van der Werff, & Lurvink, 2012; Van Riper & Kyle, 2014). The theory suggests all individuals hold a similar set of values which they prioritize in unique and highly divergent ways (Schwartz, 1992, 1994, 1996). For example, individuals may value both independent thought and action and protection of group stability through submissive self-restriction to some degree; however, their priorities of these two values could differ drastically, leading to opposite attitudes and behavioral choices. In recent work, Schwartz (2012) organized numerous existing value concepts into nineteen distinct values types. Each of these basic value types encompasses multiple specific values. For example, the value type of *hedonism* includes the values of pleasure and enjoying life, and the value type of *universalism* includes the values of being broad-minded, social justice, and equality (see Table 1 for definitions). The validity and reliability of Schwartz's basic value types have been supported by several empirical studies (Cieciuch, Schwartz, & Vecchione, 2013; Schwartz & Butenko, 2014; Schwartz et al., 2012).

Schwartz and his colleagues postulated value types relate to each other in a circular continuum of motivations (Schwartz et al., 2012, Figure 3.1). The various locations of the values in the circle reflect potential motivational conflicts or compatibilities among the specific values (Schwartz & Butenko, 2014). Adjacent values are congruent, as actions involved in pursuing one value will benefit the pursuit of the related value; opposing values conflict, as actions involved in pursuing one value usually contradict the pursuit of the opposing value (Schwartz, 1994; Schwartz et al., 2012). For example, the value type of *hedonism* is in conflict with the value type of *conformity to rules*, because individuals who value hedonism tend to pursue pleasure,

convenience, and comfort, and these behaviors may contradict conforming to rules (Schwartz, 1996).

Another central proposition of Schwartz's value theory is that behavior should have a systematic pattern of correlations with the entire value system. Specific behaviors should be most positively related to certain values, and the correlations become less and less positive as one moves around the circle and away from those specific values most strongly and positively correlated with a specific behavior (Parks-Leduc, Feldman, & Bardi, 2015). Schwartz and his colleagues were able to identify such patterns in the correlations between value types and a range of behaviors ranging from voting (Schwartz, 1996) to daily behaviors such as 'obeying parents' or 'using environmentally friendly products' (Bardi & Schwartz, 2003; Schwartz & Butenko, 2014).

Values-Low-impact Recreation Behavior Consistency

Following Schwartz's motivational circle of values, we proposed that *compliance with low impact recreation behaviors directly correlates with specific value types*. We refer to this as the value-behavior consistency proposition. Past research suggests biospheric, altruistic, and egoistic values may be most strongly correlated with compliance with low-impact recreation behavioral recommendations (Lee & Jan, 2015; Van Riper & Kyle, 2014; Wynveen et al., 2013). These values corresponded with Schwartz's value types of *universalism-nature, benevolence-dependability, benevolence-caring*, as well as *power-dominance, power-resources* and *achievement* (Table 3.1). These past studies have measured low-impact recreation behaviors as well as environmental activism and public-sphere behaviors such as attending public hearings in which environmental issues were discussed and telling other visitors to comply with low-impact recreation behavioral recommendations. In this research, we focus exclusively on private-sphere

behaviors (i.e., compliance with low-impact recreation behavioral recommendations), hypothesizing that compliance with low-impact recreation behavioral recommendations correlates with the *universalism-nature* and *achievement* value types, but not with the value types related to benevolence or power which are often associated with public sphere and public behaviors (Table 3.1).

Schwartz's value theories specified other value types that may help explain individuals' compliance with low-impact recreation behavioral recommendations but the influence of these distinct value types have not been empirically tested. Compliance with low-impact recreation behavioral recommendations can be conceptualized as a willingness to follow rules and social norms (if responsible recreation behavior is conceived as the social norm). Thus, we hypothesize that compliance positively correlates to the value types of *conformity-rules*, *conformity-interpersonal* and *tradition*, but negatively relates to the value types of *self-direction-action* (e.g., "I do whatever I want to do"). Additionally, some recommended low-impact recreation behaviors have direct implications in terms of personal safety. For example, using bear canisters to store food or hanging food away from bears would reduce human-bear conflicts, thereby protecting recreationists (Martin & McCurdy, 2009). Consequently, we also hypothesized that the value type of *security-personal* correlates with compliance with this specific low-impact recreation behavioral recommendation. Finally, complying with low-impact recreation behavioral recommendations is not always easy, convenient, or pleasant; it sometimes requires individuals to not pursue excitement or sensory gratification (e.g., stay on designated trails rather than wandering off trails to explore the unknown area). It is reasonable to hypothesize that compliance with low-impact recreation behavioral recommendations negatively correlates with the value types of *hedonism* and *stimulation*. In summary, we hypothesized compliance with

low-impact recreation behavioral recommendations correlates with nine distinct value types in Schwartz' value system (Table 3.1).

Mediation Models of Values-Attitudes-Behavior.

Cognitive-hierarchy theory suggests *the relationship between individuals' values and their compliance with low-impact recreation behavior is mediated by individuals' attitudes towards compliance*. We refer to this alternative proposition as the value-attitude-behavior mediation proposition. The cognitive-hierarchy theory proposes values are relatively stable and enduring conceptions about what is desirable and undesirable; these values inform more specific attitudes and behaviors. Values, beliefs, and attitudes that are close to the bottom of the hierarchy are believed to have more universal influences on behaviors (i.e., it will still be influential regardless of the environmental and/or social context in which the behavior occurs), while specific attitudes, behavioral intentions, and behaviors higher up the cognitive hierarchy are likely to change depending on specific environmental and/or social contexts (Figure 3.2).

The cognitive hierarchy theory has been operationalized and tested in the form of a value → attitudes → behavior mediation model. A large body of empirical research, particularly on wildlife conservation and management, has examined the effects of basic beliefs and wildlife value orientations in bridging fundamental values and behaviors (Manfredo et al., 2009; Perry-Hill et al., 2014; Sijtsma et al., 2012). Extensive research effort has also been applied to examine a variety of attitudinal factors as mediators between values and behaviors (Grob, 1995; Hayley, Zinkiewicz, & Hardiman, 2015; McCarty & Shrum, 1993; Milfont, Duckitt, & Wager, 2010; Teng, Wu, & Huang, 2014). According to the Theory of Planned Behavior and the Theory of Reasoned Action, attitudes toward specific behaviors are believed to be better predictors of behaviors compared to general (i.e., non-specific) attitudes (Eagly & Chaiken, 1993a). However,

previous research has found other attitudinal factors such as attitudes toward an object or concept may significantly influence behaviors as well. For example, Homer and Kahel found attitudes toward nutrition bridged individual values with their food shopping behavior. Milfont et al. (2010) and Papagiannakis and Lioukas (2012) found general environmental attitudes mediated the effects of values on ecological behaviors. Perry-Hill et al. (2014) found that attitudes toward a species improved how values predict species protection behaviors. There is no general consensus in the literature about whether attitudinal factors fully or partially mediate the effects of values on behaviors. Findings from McCarty and Shrum (1993), Milfont et al. (2010), and Papagiannakis and Lioukas (2012) support a full mediation model, but those from Teng et al. (2014) do not. In the context of low-impact recreation behavior, it would be useful to test which attitudinal factors influence compliance with low-impact recreation behavioral recommendations and how they might do so.

We developed four conceptual models describing the mediating role that attitudes play in the relationships between individuals' basic values and their compliance with low-impact recreation recommendations. These conceptual models were: 1) a fully mediated simple model; 2) a partially mediated simple model; 3) a parallel complex model; and 4) a chain complex model (Figure 3.3). Across these conceptual models, compliance with low-impact recreation recommendations was the dependent variable and basic values and attitudes toward specific low-impact recreation behaviors were independent variables. For the complex models, we also included other attitudinal factors (both toward following low-impact recreation recommendations and toward the study setting – the Appalachian Trail) as mediating variables likely to influence individuals' compliance with low-impact recreation behavioral recommendations.

Methods

To test both the value-behavior consistency proposition and the value-attitude-behavior mediation proposition, we collected data from two types of long-distance hikers who had recreacted on the Appalachian Trail. Approximately 2,000 individuals attempt to hike the entire trail in one year (i.e., thru-hikers), and about one in four complete the trail in its entirety that year. Others hike the entire trail over multiple years (i.e., section hikers). Long distance hikers spend extensive amounts of time on the trail and are more likely to impact vulnerable ecosystems that are visited less frequently by day-hikers. The compliance with low-impact recreation behavioral recommendations among long distance hikers is critical to protect natural resources along the Appalachian Trail. Contrary to the common perception that this group of recreationists is highly specialized and share similar backgrounds, Appalachian Trail long distance hikers are heterogeneous in their hiking experiences, preferences, and behaviors (MacLennan & Moore, 2011). The Appalachian Trail Conservancy protects and manages the Appalachian Trail, and has a need to better understand Appalachian Trail long-distance hikers to inform its ongoing visitor education efforts. We were presented with this opportunity to test theoretical propositions about values and compliance with low-impact recreation behavioral recommendations with a sample of recreationists of managerial interest and to help inform natural resource management.

Data Collection

Sampling.

Data were collected from a sample of Appalachian Trail long distance hikers using an on-line survey administered in February and March 2016. The non-probability sample was drawn from two email lists provided by the Appalachian Trail Conservancy. The first (referred to as the “2000-miler list”) included both thru-hikers who completed the entire Appalachian Trail in either

2014 or 2015 and section hikers who completed their final Appalachian Trail section in either of those years. Individuals in the sample also voluntarily registered their *completed* hike to the Appalachian Trail Conservancy in either 2014 or 2015 and gave permission for the Appalachian Trail Conservancy to contact them for Appalachian Trail-related research. The second list (referred to as the “registration list”) consisted of individuals who registered their intent to thru-hike the Appalachian Trail in 2015 through the Appalachian Trail Conservancy’s Voluntary Thru-hiker Registration System. Even though this sampling frame only included individuals who had contacted the Appalachian Trail Conservancy about their hikes, the majority of successful thru- and section-hikers on the Appalachian Trail do contact the Appalachian Trail Conservancy since their registration provides recognition of the accomplishment. The two lists were checked for overlap before being merged.

Measures.

We developed a questionnaire to measure Appalachian Trail long distance hikers’ compliance with low-impact recreation behavioral recommendations as well as the social and psychological factors believed to influence compliance (Appendix B, C). The questionnaire was developed based on the literature reviewed above as well as consultations with Appalachian Trail Conservancy experts. Psychometric scales were used to measure: 1) the frequency of compliance with low-impact recreation behaviors; 2) basic values; 3) attitudes toward four specific low-impact recreation behaviors; 4) attitudes toward following Leave No Trace principles on the Appalachian Trail; and 5) attitudes toward the Appalachian Trail itself. We also measured respondents’ backcountry experience levels, socio-demographic characteristics and other trip characteristics of managerial interest.

Low-impact recreation behavior.

We selected four low-impact recreation behaviors in consultation with Appalachian Trail Conservancy staff. These behaviors have impacted the ecological integrity of Appalachian Trail and are of concern to the Appalachian Trail Conservancy and its maintaining clubs. Respondents were asked to report the frequency in which they engaged in each behavior during their most recent thru- or section-hiking trip on five-point Likert-type scales (1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *most of the time*, 5 = *always*). The four behaviors asked about were: 1) “dig a ‘cathole’ to dispose of your human waste when a privie/outhouse was unavailable”⁹; 2) “camp on previously used campsites when you camped”; 3) “use a bear canister¹⁰ to store your food and other smellable items”; and 4) “hang your food and other smellable items”.

Values.

We used the Schwartz’s Portrait Values Questionnaire (PVQ 5X, Schwartz et al., 2012) to measure respondents’ basic values. This version of the questionnaire included 57 short statements representing 19 distinct value types. Each value type is measured with three statements. For example, “having a good time is important to him”, “enjoying life’s pleasures is important to him”, and “he takes advantage of every opportunity to have fun” describe a person for whom the *hedonism* value is important. Respondents were asked to rate how much they believed themselves to be like the hypothetical person described in each value statement on a five-point Likert-type scale that ranged from 1 (*definitely not me*) to 5 (*totally me*). The pronouns were adjusted in the online questionnaire to correspond to the respondent’s self-reported gender

⁹ “Cathole” is a common term used by hikers and natural resource managers to describe a six to eight-inch deep hole users dig in which they deposit their feces and cover afterwards.

¹⁰ A bear canister is a portable, hard-sided container that makes food and other scented items (toiletries and trash) more secure from bears, raccoons, rodents and other animals that are attracted to human food (<https://www.rei.com/learn/expert-advice/bear-resistant-canisters.html>).

as suggested by Schwartz. The only modification this study made from PVQ5X was that Schwartz et al. suggested using a six-point scale; this study used a five-point scale to include a clear middle point. This 57-item value scale is considerably longer than ones used in some previous studies (Lee & Jan, 2015; Van Riper & Kyle, 2014). However, it has some potential benefits that are worth testing in terms of low-impact recreation research. For example, portraits used in the scales are considered intuitive and easy to understand (Lindeman & Verkasalo, 2005; Schwartz et al., 2001). The PVQ5X scale measures the entire value system, which provides the opportunity to more comprehensively understand possible relationships between distinct values and compliance with specific low-impact recreation behavioral recommendations.

Attitudes

We used semantic differential scales to assess three types of attitudes including: 1) attitudes towards the four specific low-impact recreation behaviors; 2) attitudes towards following Leave No Trace principles on the Appalachian Trail; and 3) attitudes towards the Appalachian Trail itself. Specifically, attitudes toward the four specific low-impact recreation behaviors were solicited using seven-point bi-polar semantic differential scales which included the following anchor-pairs: good—bad; wise—foolish; pleasant—unpleasant; easy—hard; and convenient—tiresome. The first three anchor-pairs were from Ajzen and Fishbein (1980). The last two anchor-pairs were added to measure respondents' evaluations of low-impact recreation behavior in terms of their hedonic values (Steg et al., 2012). Attitudes toward following Leave No Trace principles on the Appalachian Trail were gauged using the same scale with an additional question about how favorably or unfavorably the respondents regarded Leave No Trace principles on a seven-point Likert-type scale ranging from 1 (*unfavorable*) to 7 (*favorable*). Attitudes toward the Appalachian Trail were measured using a different set of

anchor words describing specific attributes toward the Appalachian Trail. These six pairs of anchor words included: natural—artificial; unique—common; wilderness-like—urban-like; quiet—noisy; safe from crime—unsafe from crime; and scenic—unattractive. The positive adjectives were selected first, informed by the Appalachian Trail Conservancy’s mission and a 1999 Appalachian Trail User survey (Manning et al., 2000), this was followed by the identification of antonyms of the positive adjectives.

Survey implementation.

We administered the survey through the on-line platform Qualtrics using a modified version of Dillman’s Tailored Design method (Dillman, Smyth, & Christian, 2009). From February to March 2016, we sent emails to 2,813 potential respondents; this included a pre-notice from the Appalachian Trail Conservancy and a study invitation with a link to the survey from the research team (Appendix D). The initial invitation was followed by three waves of reminders for those who had not completed the survey (Appendix D). A total of 103 emails were bounced because of invalid email addresses. A total of 1,485 individuals participated in the survey in a four-week period resulting in an overall response rate of 54.8%¹¹. No further contacts were made to non-respondents due to limited resources. Caution should be used in generalizing results to all Appalachian Trail long distance hikers, as there is no comprehensive list from which a truly “representative” sample can be drawn.

¹¹Difference in response rates was observed between the two sample lists. For the 2000-miler list, 729 surveys were collected resulting in a response rate of 70.8%. For the registration list, 756 surveys were collected, resulting in a response rate of 45.0%.

Data Analysis

Data cleaning.

Data were cleaned and analyzed using IBM SPSS Statistics 22 and SAS version 9.4. We excluded 73 individuals (4.9% of all respondents¹²) who registered through the Appalachian Trail Conservancy's Voluntary Thru-hiker Registration System, but did not actually begin their planned thru-hike in 2015. We also excluded from the analysis 52 individuals (3.5% of all respondents⁵) who did not respond to 20% or more of the low-impact recreation behavior measures and 200 individuals (13.5% of all respondents) who did not respond to 20% or more of the items included in the PVQ5X scale. The final dataset used for the analyses reported here included responses from 1,209 hikers.

Data analysis.

To test the values-behavior consistency proposition, we conducted Pearson correlation analyses between each value type and each of the four low-impact recreation behaviors using the PROC CORR procedure in SAS version 9.4. We used the sum of items belonging to each value type as the composite value score. A limitation of this common practice is that it assumes each item loads equally on the latent variate value type, which may not always be the case in reality (Guo & Schneider, 2015). Thus, we also conducted canonical correlation analyses to check the results from the Pearson correlation analyses.¹³ A significance level of .05 was used.

To test the values-attitudes-behavior mediation proposition, we fitted four structural equation models for each recommended low-impact recreation behavior using the PROC CALIS

¹² Calculated with the total number of surveys collected as denominator (n=1,485)

¹³ This multi-variate correlation analysis technique determines a set of canonical variates (orthogonal linear combinations of the variables) within each set of variables that best explains the variability both within and between the two sets (Johnson & Wichern, 2007). By using this method, each value type was treated as a latent variate and no presumption was posited on how each value item is loaded on the latent variable.

procedure. A visual representation of the four models is presented in Figure 3.3. We first fitted the measurement models separately for the values and attitudes scales. After testing the goodness of fit of the measurement models, we fitted the structural models. This sequence is commonly applied in structural equation modeling (Brown, 2006; Kline, 2003; Iacobucci, 2010). The first two models (i.e., fully or partially mediated simple models) included basic values pertinent to the behavior and attitudes toward each low-impact recreation behavior as the predictor, and compliance with recommended low-impact recreation behavior as the response. The nine value types that were hypothesized to be relevant to complying with low-impact recreation behavioral recommendations, regardless of their significance or insignificance in the correlational analysis, were kept in the model. For each low-impact recreation behavioral recommendation, the value types found to be significant in the correlational analysis but not hypothesized as significant were added to the models as well. We tested both a fully mediated and a partially mediated model in which value types directly influenced compliance with low-impact recreation behavioral recommendations. The third and fourth models included attitudes toward the Appalachian Trail and toward Leave No Trace principles as mediators. The parallel model specified the three attitudinal factors all influenced by the values and then directly influencing behavior. The chain model hypothesized a sequence of attitudinal factors starting from attitude toward the Appalachian Trail, to attitude toward following Leave No Trace principles on the Appalachian Trail, then to attitudes toward specific recommended low-impact recreation behaviors.

Following Bentler (1990), Brown (2006), Hu and Bentler (1999), and Iacobucci (2010), five model goodness-of-fit indices were used to evaluate the models; these included: (1) the standardized root mean square residual (SRMR); (2) the root mean square error of approximation (RMSEA); (3) the comparative fit index (CFI); (4) the Turcker-Lewis index (TLI, or Bentler-

Bonett nonnormed coefficient); and (5) Alaike's information criteria (AIC). Hu and Bentler (1999) suggested a model with adequate fit to the data should have values of SRMR and RMSEA less than .08. Bentler (1990) suggested CFI and TLI values in the range of .90 to .95 be indicative of acceptable model fit. AIC was used to compare models; the lower the AIC score, the better. Relative χ^2 and degrees of freedom were reported but not used to evaluate the models because their use has been "strongly discouraged" due to sensitivity to sample size (Brown, 2006, p.89). After examining model fit indices, we examined the R^2 and path coefficients for models with acceptable fit to determine how well the models predicted the compliance with low-impact recreation behavioral recommendations and whether the constructs predicted compliance with low-impact recreation behavioral recommendations in the same direction as hypothesized.

Results

Respondents' Profile

Of the 1,209 Appalachian Trail Long Distance Hikers analyzed for this study, the majority (67.1%) were male and white (94.5%; Table 3.2)¹⁴. The average age of respondents was 42 (S.D. = 16.3). The total household income (before taxes) in a typical year was evenly distributed, with 25.3% having incomes of \$100,000 or more, and 22.3% having incomes less than \$20,000¹⁵. About 6.1% of respondents were from countries other than the U.S., among whom 30.6% were from Germany, 26.4% from Canada, 11.1% from the United Kingdom, 5.6% from Australia and 26.3 % other countries¹⁶. The majority of respondents (60.3%) were thru-

¹⁴ A total of 18 respondents did not identify with any racial group.

¹⁵ Compared to a previous study of A.T. hikers (Manning et al., 2000), our sample had a higher percentage of female respondents. The age composition of our sample was similar to a previous on-line survey of A.T. hikers (Adams, 2014); both previous studies had higher percentages of individuals over 60 compared to the on-site survey (Manning et al., 2000) suggesting on-line surveys may reach slightly different age groups than on-site surveys.

¹⁶ The countries included Austria, Azerbaijan, Belgium, Finland, France, Hungary, Libya, Israel, Italy, New Zealand, Peru, Singapore, Sweden, Switzerland and Thailand.

hikers who completed their hike in 2014 or 2015, followed by a smaller proportion of section hikers who completed the hike in 2014 or 2015 (9.6%). About a third (30%) of hikers in the sample started their thru-hike in 2015 but did not finish; these hikers on average hiked 757.7 miles on the Appalachian Trail in 2015 (S.D. = 576.5). Most respondents identified their level of hiking experience before their Appalachian Trail trip as average ($\bar{x} = 3.8$, with 1 = *novice*, 7 = *expert*). Only 5.5% respondents identified themselves as experts in backcountry hiking before their most recent Appalachian Trail hiking trip.

Descriptive of Compliance and Values

Respondents reported high compliance with three out of four recommended low-impact recreation behaviors during their most recent Appalachian Trail thru- or section-hiking trips. Specifically, respondents indicated they “dug a cathole to dispose of human waste when a privie/outhouse was unavailable” more than “most of the time” ($\bar{x} = 4.3$, S.D. = 1.1, on a five point scale with 1 = *never*, 5 = *always*), “camped on previously used campsites when they camped” ($\bar{x} = 4.1$, S.D. = 0.7), and “hung food and other smellable items” ($\bar{x} = 3.7$, S.D. = 1.1). The majority of respondents reported they complied with these recommended low-impact recreation behaviors always or most of the time. However, 84.8% respondents never used a bear canister during their most recent Appalachian Trail hiking trip. Only 70 respondents (5.8% of all respondents) used a bear canister either ‘most of the time’ or ‘always’.

Respondents rated 57 value statements based on how alike they believed they were with the person described in the statements (Table 3.3). The top three statements the respondents identified with the most were “He/she/they strongly believes that he/she/they should care for nature” ($\bar{x} = 4.8$, S.D. = 0.5, on a five point scale with 1 = *definitely not me*, 5 = *totally me*), “Learning things for himself/herself/themselves and improving his/her/their abilities is important

to him/her/them" ($\bar{x} = 4.7$, S.D.= 0.6), and "It is important to him/her/them to make his/her/their own decisions about his/her/their life" ($\bar{x} = 4.7$, S.D. = 0.5), all three statement items belong to the broad value types of *universalism* and *self-direction*. The three value items respondents identified with the least were "It is important to him/her/them to be the most influential person in any group" ($\bar{x} = 2.2$, S.D. = 1), "It is important to him/her/them to be the one who tells others what to do" ($\bar{x} = 2.1$, S.D. = 0.9), and "He/she/they pursues high status and power" ($\bar{x} = 2.0$, S.D. = 1.0). These three statement items belong to the *power* value type. The three statement items with the largest variation were all related to the *tradition* value type, this included "He/she/they strongly values the traditional practices of his/her/their culture" ($\bar{x} = 2.8$, S.D. = 1.2), "It is important to him/her/them to maintain traditional values or beliefs ($\bar{x} = 3.0$, S.D. = 1.3)", and "Following his/her/their family's customs or the customs of a religion is important to him/her/them" ($\bar{x} = 2.6$, S.D. = 1.4). Items in each value type had Cronbach α coefficients over .6 showing consistency in the multivariate measurement of value types.

Value-Behavior Consistency

Results from the correlation analyses supported the general proposition that compliance with low impact recreation behaviors directly correlates with specific value types (Table 3.4)¹⁷. However, which value types significantly correlate with specific behaviors were not always consistent with our hypotheses. Among the nine value types hypothesized to correlate with compliance with low impact recreation behavioral recommendations, the value type of

¹⁷ Table 4 reports correlations significant in both Pearson and canonical correlation analyses. Most results from Pearson correlation analyses were consistent with canonical correlation analyses. However, five pairs of value type and compliance with low-impact recreation behavioral recommendations were significant for Pearson correlation but not for canonical correlation analyses, including 1) digging a cathole and *Universalism-tolerance*, 2) camping on previously used campsites and *Power-resources*, 3) camping on previously used campsites and *Security-societal*, 4) hanging food and other smellable items and *Hedonism*, and 5) hanging food and other smellable items and *Benevolence-dependability*. Two pairs were found significant in canonical correlation analysis but not in Pearson correlation analysis, including digging a cathole and *Achievement* and Hanging food and *Achievement*. These correlations were not reported in Table 4. Further studies are needed to explain why these results were inconsistent.

conformity-rules most consistently correlated with three of four low-impact recreation behaviors (i.e., digging a cathole, using previously used campsites, and hanging food and smellable items), followed by the *stimulation* and *tradition* value types, which were correlated with two of the four low-impact recreation behaviors queried about. The *self-direction-action* and *conformity-interpersonal* value types were hypothesized to correlate with compliance with low-impact recreation behavioral recommendations, but the data revealed no significant correlations. All significant correlation coefficients were less than 0.2. The relationships between values and compliance with low-impact recreation behavioral recommendations were not all significant.

For the recommended low-impact recreation behavior of digging a cathole when a privie/outhouse was not available, individuals who strongly valued *stimulation* ($r = -0.07$) and *Hedonism* ($r = -0.06$) were less likely to dig a cathole, which is the recommended low-impact recreation behavior (Table 3.4). Digging a cathole is not usually convenient or fun and a strong value of hedonism or stimulation may inhibit individuals from complying with this recommendation. Individuals who valued *conformity-rules* ($r = 0.08$) and *universalism-nature* ($r = 0.09$) were more likely to use catholes. Counter to our hypotheses, we found individuals who valued *self-direction-thought* ($r = 0.08$) and *universalism-concern* ($r = 0.12$) tended to dig a cathole when there was no privie or outhouse available. Individuals who valued *power-dominance* ($r = -0.07$) and *power-resources* ($r = -0.09$) were less likely to dig a cathole. The power values relate with egocentric value orientations, suggesting catholes are not likely to be used by individuals who value their own experience over the experiences of others.

For the recommended low-impact recreation behavior of camping on previously used campsites, as hypothesized, individuals who valued *conformity-rules* more strongly tended to camp on previously used campsites ($r = 0.08$; Table 3.4). In addition to being a responsible low-

impact behavior, camping only on previously used campsites is an established policy along some parts of the Appalachian Trail. It was not surprising to see a relationship between the values of conforming to rules and compliance with recommended low-impact recreation behaviors. We did not expect to find that individuals who held stronger *power-dominance* values to indicate they camped on previously used campsites ($r = 0.10$).

For the recommended low-impact recreation behavior of using a bear canister to store food and other smellable items, only one value type was found significantly correlated with the behavior at the 0.05 level: *tradition* ($r = 0.08$; Table 3.4). We found that very few respondents used a bear canister during their trips on the Appalachian Trail. The few people who used one may learn the behavior from past recreation experiences which could suggest particular traditions. It was also interesting that the value type of *hedonism* was not significantly correlated with the use of canisters, given that carrying a canister over a 2000-mile hiking trip could be cumbersome.

For the last recommended behavior of hanging food and other smellable items, as expected, individuals who value *stimulation* ($r = -0.06$) were less likely to hang food and other smellable items. Individuals who valued *security-personal* ($r = 0.11$), *tradition* ($r = 0.09$), and *conformity-rules* ($r = 0.02$) were more likely to hang food and smellable items. Hanging food to prevent bears searching for and getting human food is important for recreationists' personal safety and many areas along the Appalachian Trail have such policies about food storage. Our results suggest this low impact recreation behavioral recommendation is aligned with individuals' values of security, conformity to rules, and tradition. We did not expect that the value types of *security-societal*, *benevolence-caring*, and *universalism-concern* would be positively associated with compliance with hanging food and other smellable items. However,

these value types could be conceptualized as values beyond the individual's immediate own interests (i.e., self-transcendent or pro-social values). These broader value types have been found to be associate with pro-environmental behavior in previous studies (Steg et al., 2012; Steg & Vlek, 2009; Van Riper & Kyle, 2014).

Values-Attitudes-Behavior Mediation Models

We used goodness of fit indices to determine if the relationships we proposed among values, attitudinal factors, and behaviors were observed in our data (Table 3.5). Although most models presented SRMR and RMSEA less than .08, most of their incremental indices including CFI and TLI fell under 0.9. We also observed a few borderline CFI and TLI values (e.g., the fully mediated simple model for using catholes, CFI= 0.89, TLI =0.87). The inconsistency among the goodness-of-fit indices and their close-to-borderline values added difficulty in determining whether these models actually fit the data or not. As an initial attempt to test the value-attitudes-behavior mediated models in the context of low impact recreation behavior, we consider CFI or TLI values close to 0.9 acceptable. We accepted four models, including the three fully mediated simple model (values → attitudes toward the behavior → compliance with the recommended behavior) for the behaviors of using catholes, camping only on previously used campsites, and using a bear canister, and a partially mediated simple model (i.e., adding a direct path from values to the behavior to the fully mediated simple model) for the behavior of digging a cathole. However, it is worth noting support for the chain effects from values through attitudes on behaviors is not strong in the data.

Based upon the goodness of fit indices, the fully mediated simple model best described the relationship between values, attitudes, and behaviors except for hanging food and other smellable items. No values-attitudes-behavior model yielded an acceptable fit for the behavior of

hanging food and other smellable items, calling for future examination of this behavior, particular in comparison to other food-storage behavior (e.g., using a bear canister).

We examined the coefficients and R^2 of the three fully mediated simple models to further assess the values-attitudes-behaviors models. Consistently, the value type of *universalism-nature* significantly predicted individual attitudes toward the three low-impact recreation behavioral recommendations. However, values explained less than 10% of the variance of attitudes, suggesting that individuals' attitudes may be formed through other avenues such as past behaviors and cost-benefit assessments rather than based on personal values (Table 3.6, 3.7, 3.8; Summaries of respondents' attitudes see Appendix E). Across the same fully mediated models, attitudes explained 10.9% to 22.3% of the variances of compliance, which was consistent with past prediction models studies of low-impact recreation behavior (See Chapter Two of the dissertation). All the standardized coefficients of attitudes were larger than 0.3 suggesting clear effects of attitudes on the behavior.

For the fully mediated model predicting compliance with the recommended behavior of digging a cathole when a privie/outhouse was not available, seven value types significantly predicted respondents' attitudes toward the behavior (Table 3.6). Individuals, who valued *universalism-nature* ($\beta = 0.16$ ¹⁸), *conformity-rules* ($\beta = 0.14$), *power-resource* ($\beta = 0.15$), and *hedonism* ($\beta = 0.16$) tended to hold more positive attitudes toward digging a cathole to dispose of human waste. Conversely, individuals who valued *achievement* ($\beta = -0.18$), *power-dominance* ($\beta = -0.11$, and *conformity-interpersonal* ($\beta = -0.12$) tended to hold negative attitudes towards digging a cathole. The seven value types only explained 7.9% of the variance in measures of attitudes. The results were not consistent with what we found regarding value-behavior consistency. It was surprising that the value type of *hedonism* positively affected attitudes toward

¹⁸ All "β" s reported in this chapter are standardized.

digging a cathole considering the behavior is not convenient or fun. This result may be better interpreted as individuals who value pleasure and sensory gratification (i.e., *hedonism* values) also hold positive attitudes toward digging a cathole. The conflict between the value type of *hedonism* and the low impact recreation behavior was not as strong as we hypothesized. Not surprisingly, attitudes toward digging a cathole significantly predicted individuals' compliance with the recommended low-impact recreation behavior ($\beta = 0.33$).

For the fully mediated model predicting compliance with the recommended behavior of camping on previously used campsites, three value types were significant predictors of attitudes toward the behavior (Table 3.7). Individuals who valued *universalism-nature* ($\beta = 0.15$), *power-dominance* ($\beta = 0.09$), and *conformity-rules* ($\beta = 0.08$) tended to view camping on previously used campsites more positively. The same correlations were observed between the behavior of camping on previously used campsites and the value types of *power-dominance* and *conformity-rules*. Attitudes toward the behavior significantly and moderately influenced the compliance ($\beta = 0.39$).

For the fully mediated model predicting compliance with the recommended behavior of using a bear canister to store food and other smellable items, individuals who valued *tradition* ($\beta = 0.16$), and *universalism-nature* ($\beta = 0.09$) more strongly, were more likely to hold positive attitudes toward the behavior (Table 3.8). From previous analyses, the behavior of using canisters to store food and other smellable items was also correlated with the value type of *tradition*, but not with the value type of *universalism-nature*. Additionally, individuals' attitudes toward the behavior significantly predicted compliance ($\beta = 0.47$).

Discussion

In this study, we examined two ways in which values may relate to compliance with low-impact recreation behavioral recommendations using data from long-distance Appalachian Trail hikers. The first purpose of the study was to test hypotheses about value-behavior consistency based on Schwartz's value theory. Our findings supported the general proposition that compliance with low-impact behavioral recommendations directly relates to specific value types. The value type of *conformity-rules* most consistently related to the use of catholes ($r = 0.08$) and hanging food and other smellable items ($r = 0.08$) and the use of previously used campsites ($r = 0.02$). However, for the other value types, the relationships between them and specific low-impact recreation behavioral recommendations were not always in the direction hypothesized.

The second purpose of the study was to test a mediation model of the effects of values on behaviors through attitudes based on the cognitive hierarchy theory. The results partially supported the proposition that values influence compliance with low-impact behavioral recommendations through mediating attitudinal factors. The fit of fully mediated values → attitudes toward behavior → behavior model was on the borderline for most of the behaviors queried about except the behavior of hanging food and other smellable items. Consistently, the value type of *universalism-nature* was a significant predictor of attitudes toward digging a cathole, camping on previously camped campsites, and using a bear canister; this is consistent with previous studies on low-impact recreation behavior and with the broader pro-environmental behavior literature. More complex models with attitudes toward Leave No Trace principles and attitudes toward the Appalachian Trail as mediators were not supported.

We were only able to find a weak and mixed signal for direct and indirect relationships between values and compliance with low-impact recreation behavioral recommendations. We

conceptualized how values relate to behaviors (i.e., through values-behavior consistency or a mediation model) based on Schwartz's value theory and the cognitive hierarchy theory. This theoretical foundation consisting of two rarely tested theories may not be broad enough to account for the complexity of the values-behavior relationship. For example, we did not evaluate the effects of normative factors on compliance.

This study is the first low-impact recreation behavior study to utilize the PVQ 5X scale to measure recreationsts' values. The scale itself performed well and provided additional information about individual values relative to what would be provided by other shorter value-scales. However, it seems this information did not improve our ability to explain compliance with low-impact recreation behavior. A potential improvement is to measure values using scenarios in which individuals need to select among behavioral options that correspond to conflicting values (Gramann, Bonifield, & Kim, 1995). Such measurement would reflect two views of values that were not examined in this study. First the effects of values depend on contexts. Second, the process of weighing conflicting values and assigning one value higher priority than others may, in fact, influence compliance with low-impact recreation behavior rather than the independent scores for each value. Future studies using contextualized and comparative value measures integrated with observed behavior measures might be able to shed more light on the value-behavior relationship..

The mixed support for the proposed hypotheses suggests a need to reconsider how hypotheses regarding value-behavior relationships are formed. We used a deductive approach where each hypothesis was based on a view of compliance with low-impact recreation behavioral recommendations as pro-environmental, pro-social, rational behavior involving cost and benefit assessments. If low-impact recreation behavior is comparable to pro-environmental

and pro-social behavior, we should be able to see compliance with various low-impact recreation behavioral recommendations almost always correlate with the value types of *universalism-nature*, but negatively associate with egoistic values (i.e., *stimulation, hedonism, achievement, and power*). However, these value types did not always correlate with compliance with low-impact recreation behavioral recommendations as expected. Our hypothesis-making process did not reflect the possibility that individuals are capable of holding conflicting values simultaneously. We hypothesized compliance with low-impact recreation behavioral recommendations would not correlate with the value types related to benevolence or power because the target behaviors did not directly involve other people. However, our analyses revealed values related to power correlated with more than one behavior. It is possible the hypotheses-making process did not allow for a full consideration of how a low-impact recreation behavioral recommendation might influence other individuals. There are likely norms attached to low-impact recreation behaviors, thus linking compliance with values associated with social interaction. In sum, our deductive hypotheses-making process might have contributed to the muddy findings.

Limitations and Future Research

There are a few limitations of this study. We used self-reported measures of behaviors. Although researchers have argued that self-reported behavior measures are valuable in providing information about visitor behaviors (Manfredo & Bright, 1991), there have been mixed findings about the correlation between self-reported and observed behavior measures (Jett, 2007; Park et al., 2008; Reigner & Lawson, 2009). In future studies we intend to test the value-behavior relationship using observed behavior measures.

Additionally, we were only able to examine about half the people in our contact lists. The 54.8% response rate is not low for on-line survey without incentives, but still limited our ability to make inferences about what the other half of the hikers might think or do. Limited resources prevented us from assessing non-response bias. We recommend adding incentives in future studies to help reach individuals who may particularly value financial benefits. Our sample was likely younger and had more females than the population of Appalachian Trail hikers. Caution should be used in generalizing our results to all Appalachian Trail long distance hikers or related populations.

Our research questions focused on linear relationships between values, attitudes, and behaviors at the individual level. To advance this line of research, future research should adopt a temporal-oriented multi-theory and multi-phasic approach (See Chapter Two of this dissertation). The effects of values could be studied by priming value types through messages or environmental cues (Steg, Bolderdijk, Keizer, & Perlaviciute, 2014) and then examining the effects of attitudinal factors on compliance with low-impact recreation behaviors. The value-behavior relationship could also be examined at higher levels such as comparing groups with different cultural backgrounds or from different regions. Such analysis may be able to shed light on how psychological factors intertwine with sociological factors in influencing behaviors. Additionally, future research on values and low-impact recreation behavior should consider reaching recreationists who feel strongly opposed to following low-impact recreation behavioral recommendations. Understanding these individuals' perspectives may help shed light on the relationships between values and compliance.

Managerial Implications

Understanding recreationists' values can be valuable in helping design effective educational messaging that appeals to distinct values. For example, we found the value type of *universalism-concern* positively correlated with digging a cathole and hanging food and smellable items. Messages that highlight the social aspects of these recommended low-impact recreation behaviors (e.g., maintain an aesthetic, clean and safe recreation environment for others) might help promote the compliance. Environmental cues or programming to prime these distinct values such as signage or commitment programs might also be helpful. However, it is worth noting that we found the effects of values on compliance with low-impact recreation behaviors are limited. This suggests the ties between the low-impact recreation behaviors we studied and individual values are not strong. This finding may be in fact good news since it suggests depreciative recreation behaviors can be changed through visitor education and information programs without interfering with individual fundamental values, which are hard to change. Managers should be cautious not to alienate visitors who do not comply with low-impact recreation behavioral recommendations by assuming they hold different values from those managers hold. More emphasis should be placed on why managers recommend these behaviors and how visitors could help managers protect natural resources.

Conclusions

We found Appalachian Trail long distance hikers tended to comply with the low-impact recreation behavioral recommendations of “digging a cathole when a privie/outhouse is not available”, “camping on previously used campsites”, and “hanging food and other smellable items”, but not with “using a bear canister to store food and other smellable items.” Each of these behaviors related to different value types. The value type of *conformity-rules* significantly

correlated with the most low-impact recreation behavioral recommendations tested in this study. The complex value-attitudes-behavior mediation model based on cognitive-hierarchy theory was not supported in this study, suggesting the relationship among values, attitudes toward a target, attitudes toward a concept, attitudes toward behavior, and behaviors is more complex than linear models. The simple value-attitudes-behavior fully mediated models were supported however, confirming the effects of attitudes towards behavior on behavioral compliance. It is our hope this study and related ones in the future will assist natural resource managers in their efforts to better understand and engage visitors in protecting the natural resources and sustaining high quality outdoor recreation opportunities.

Reference

- Adams, B. M. W. (2014). *The relative importance of user characteristics, natural resource-oriented experiential education, and concern for the environment in influencing visitors' responsible environmental behavior in backcountry areas*. North Carolina State University.
- Bardi, A., & Schwartz, S. H. (2003). Values and behavior: strength and structure of relations. *Personality and Social Psychology Bulletin*, 29(10), 1207–1220.
<http://doi.org/10.1177/0146167203254602>
- Bentler, P. M. (1990). Comparative fit indices in structural models. *Psychological Bulletin*, 107, 238–246.
- Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. New York, NY: The Gilford Press.
- Cieciuch, J., Schwartz, S., & Vecchione, M. (2013). Applying the refined values theory to past

- data: what can researchers gain? *Journal of Cross - Cultural Psychology*, 44(8), 1215.
<http://doi.org/10.1177/0022022113487076>
- de Groot, J. I., & Steg, L. (2009). Mean or green: which values can promote stable pro-environmental behavior? *Conservation Letters*, 2, 61–66. <http://doi.org/10.1111/j.1755-263X.2009.00048.x>
- Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009). *Internet, Mail, and Mixed-mode Surveys: The Tailored Design Method* (3rd ed.). Hoboken, NJ: John Wiley & Sons.
- Eagly, A. H., & Chaiken, S. (1993). The impact of attitudes on behaviors. In *The Psychology of Attitudes* (pp. 155–217). Orlando, FL: Harcourt Brace & Company.
- Fulton, D. C., Manfredo, M. J., & Lipscomb, J. (1996). Wildlife value orientations: a conceptual and measurement approach. *Human Dimensions of Wildlife*, 1(2), 24–47.
<http://doi.org/10.1080/10871209609359060>
- Gramann, J., Bonifield, R., & Kim, Y.-G. (1995). Effect of personality and situational factors on intentions to obey rules in outdoor recreation areas. *Journal of Leisure Research*. Retrieved from <http://www.questia.com/googleScholar.qst?docId=5000369730>
- Grob, A. (1995). A structural model of environmental behaviour attitudes. *Journal of Environmental Psychology*, 15(4), 209–220. [http://doi.org/10.1016/0272-4944\(95\)90004-7](http://doi.org/10.1016/0272-4944(95)90004-7)
- Guo, T., & Schneider, I. (2015). Measurement properties and cross-cultural equivalence of negotiation with outdoor recreation constraints an exploratory study. *Journal of Leisure Research*, 47(1), 125–153.

Hayley, A., Zinkiewicz, L., & Hardiman, K. (2015). Values, attitudes, and frequency of meat consumption: Predicting meat-reduced diet in Australians. *Appetite*, 84, 98–106.
<http://doi.org/10.1016/j.appet.2014.10.002>

Homer, P. M., & Kahle, L. R. (1988). A structural equation test of the value^attitude)ehavior hierarchy. *Journal of Personality and Social Psychology*, 54(4), 638–646.
<http://doi.org/10.1037/0022-3514.54.4.638>

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <http://doi.org/10.1080/10705519909540118>

Iacobucci, D. (2010). Structural equations modeling: Fit Indices, sample size, and advanced topics. *Journal of Consumer Psychology*, 20(1), 90–98.
<http://doi.org/10.1016/j.jcps.2009.09.003>

Jacobs, M. H., Vaske, J. J., & Sijtsma, M. T. J. (2014). Predictive potential of wildlife value orientations for acceptability of management interventions. *Journal for Nature Conservation*, 22(4), 377–383. <http://doi.org/10.1016/j.jnc.2014.03.005>

Jett, J. S. (2007). *Boater compliance behavior in manatee conservation zones: Recreation specialization, attitudes and situational factors*. University of Florida. Retrieved from <http://search.proquest.com/docview/304869811?accountid=30037>

Johnson, R. A., & Wichern, D. W. (2007). Canonical correlation analysis. In *Applied multivariate statistical analysis* (6th ed., pp. 539–574). Upper Saddle River, NJ: Pearson Education, Inc.

Lawhon, J. B. (2013). *Influencing Leave No Trace Behavioral Intentions in Frontcountry Visitors to National and State Parks*. Colorado State University.

Lee, T. H., & Jan, F. H. (2015). The effects of recreation experience, environmental attitude, and biospheric value on the environmentally responsible behavior of nature-based tourists. *Environmental Management*, 56(1), 193–208. <http://doi.org/10.1007/s00267-015-0488-y>

Lindeman, M., & Verkasalo, M. (2005). Measuring values with the short schwartz ' s value survey measuring values with the short schwartz ' s value survey. *Journal of Personality Assessment*, 85(2), 37–41. <http://doi.org/10.1207/s15327752jpa8502>

MacLennan, J., & Moore, R. L. (2011). Conflicts between recreation subworlds: the case of Appalachian Trail long-distance hikers. *LARNet The Cyber Journal of Applied Leisure and Recreation Research*, 13(1), 1–17.

Manfredo, M. J., & Bright, A. D. (1991). A model for assessing the effects of communication on recreationsits. *Journal of Leisure Research*, 23(1).
<http://doi.org/10.1017/CBO9781107415324.004>

Manfredo, M. J., Teel, T. L., & Henry, K. L. (2009). Linking society and environment: A multilevel model of shifting wildlife value orientation in the western United States. *Social Science Quarterly*, 90(2), 407–427. <http://doi.org/10.1111/j.1540-6237.2009.00624.x>

Manning, R. E., Valliere, W., Bacon, J. J., Hennessy, R., Graefe, A., Kyle, G., & Hennessy, R. (2000). *Use and users of the Appalachian Trail a source book*. Retrieved from http://www.nps.gov/appa/parkmgmt/upload/Main_Report-2.pdf

- Marion, J. L., Leung, Y., Eagleston, H., & Burroughs, K. (2016). A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry*, 114(May), 1–17. <http://doi.org/10.5849/jof.15-498>
- Martin, S. R., & McCurdy, K. (2009). Wilderness food storage in Yosemite: Using the theory of planned behavior to understand backpacker canister use. *Human Dimensions of Wildlife*, 14(July 2015), 206–218. <http://doi.org/10.1080/10871200902858993>
- McCarty, J. A., & Shrum, L. J. (1993). A structural equation analysis of the relationships of personal values, attitudes and beliefs about recycling, and the recycling of solid waste products. *Advances in Consumer Research*, 20, 641–646.
- Milfont, T. L., Duckitt, J., & Wager, C. (2010). A cross-cultural test of the value –attitude–behavior hierarchy. *Journal of Applied Social Psychology*, 40(11), 2791–2813.
- Papagiannakis, G., & Lioukas, S. (2012). Values, attitudes and perceptions of managers as predictors of corporate environmental responsiveness. *Journal of Environmental Management*, 100, 41–51. <http://doi.org/10.1016/j.jenvman.2012.01.023>
- Park, L. O., Manning, R. E., Marion, J. L., Lawson, S. R., & Jacobi, C. (2008). Managing visitor impacts in parks: A multi-method study of the effectiveness of alternative management practices. *Journal of Park and Recreation Administration*, 26(1), 97–121.
- Parks-Leduc, L., Feldman, G., & Bardi, A. (2015). Personality traits and personal values: A meta-analysis. *Personality and Social Psychology Review*, 19(1), 3–29.
<http://doi.org/10.1177/1088868314538548>

- Perry-Hill, R., Smith, J. W., Reimer, A., Mase, A. S., Mullendore, N., Mulvaney, K. K., & Prokopy, L. S. (2014). The influence of basic beliefs and object-specific attitudes on behavioural intentions towards a rare and little-known amphibian. *Wildlife Research*, 41(4), 287–299. <http://doi.org/10.1071/WR13218>
- Reigner, N., & Lawson, S. R. (2009). Improving the efficacy of visitor education in Haleakala National Park using the Theory of Planned Behavior. *Journal of Interpretation Research*, 14(2), 21–45. <http://doi.org/Retrieved from www.interpnet.com>
- Schwartz, S. H. (1992). Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. In M. Zanna (Ed.), *Advances in Experimental Social Psychology* (Vol. 25, pp. 1–65). Orlando, FL.
- Schwartz, S. H. (1994). Are there universal aspects in the structure and content of human values? *Journal of Social Issues*, 50(4), 19–45.
- Schwartz, S. H. (1996). Value priorities and behavior: applying a theory of integrated value systems. In C. Seligman, J. M. Olson, & M. P. Zanna (Eds.), *The Psychology of Values: The Ontario Symposium, Volume 8*. Mahwah, NJ: Lawrence Erlbaum Associates Inc.
- Schwartz, S. H., & Butenko, T. (2014). Values and Behavior: Validating the Refined Values Theory in Russia. *Researchgate.Net*, 813(November 2013), 799–813.
<http://doi.org/10.1002/ejsp.2053>
- Schwartz, S. H., Cieciuch, J., Vecchione, M., Davidov, E., Fischer, R., Beierlein, C., ... Konty, M. (2012). Refining the theory of basic individual values. *Journal of Personality and Social Psychology*, 103(4), 663–688. <http://doi.org/10.1037/a0029393>

- Schwartz, S. H., Melech, G., Lehmann, A., Burgess, S., Harris, M., & Owens, V. (2001). Extending the cross-cultural validity of the theory of basic human values with a different method of measurement. *Journal of Cross-Cultural Psychology*, 32(5), 519–542.
<http://doi.org/10.1177/0022022101032005001>
- Sijtsma, M. T. J., Vaske, J. J., & Jacobs, M. H. (2012). Acceptability of lethal control of wildlife that damage agriculture in the Netherlands. *Society & Natural Resources*, 25(12), 1308–1323. <http://doi.org/10.1080/08941920.2012.684850>
- Steg, L., Bolderdijk, J. W., Keizer, K., & Perlaviciute, G. (2014). An integrated framework for encouraging pro-environmental Behaviour: the role of values, situational factors and goals. *Journal of Environmental Psychology*, 38, 104–115.
<http://doi.org/10.1016/j.jenvp.2014.01.002>
- Steg, L., Perlaviciute, G., van der Werff, E., & Lurvink, J. (2012). The significance of hedonic values for environmentally relevant attitudes, preferences, and actions. *Environment and Behavior*, 46(2), 163–192. <http://doi.org/10.1177/0013916512454730>
- Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, 29(3), 309–317.
<http://doi.org/10.1016/j.jenvp.2008.10.004>
- Teng, Y.-M., Wu, K.-S., & Huang, D.-M. (2014). The influence of green restaurant decision formation using the VAB model: the effect of environmental concerns upon intent to Visit. *Sustainability*, 6(12), 8736–8755. <http://doi.org/10.3390/su6128736>
- Vagias, W. M., Powell, R. B., Moore, D. D., Wright, B. a., Brett, A., & Wright, B. a. (2014).

- Predicting behavioral intentions to comply with recommended Leave No Trace practices.
Leisure Sciences : An Interdisciplinary Journal, 36(5), 37–41.
<http://doi.org/10.1080/01490400.2014.912168>
- Van Riper, C. J., & Kyle, G. T. (2014). Understanding the internal processes of behavioral engagement in a national park: A latent variable path analysis of the value-belief-norm theory. *Journal of Environmental Psychology*, 38, 288–297.
<http://doi.org/10.1016/j.jenvp.2014.03.002>
- Vande Kamp, M. E., Johnson, D. R., & Sewaringen, T. C. (1994). *Deterring minor acts of noncompliance a literature review*. Seattle, WA.
- Vaske, J. J., & Donnelly, M. P. (1999). A value-attitude-behavior model predicting wildland preservation voting intentions. *Society & Natural Resources*, 12(6), 523–537.
<http://doi.org/10.1080/089419299279425>
- Vaske, J., Maureen, Donnelly, P., & Dani, J. (2001). Demographic influences on environmental value orientations and normative beliefs about National Forest management. *Society & Natural Resources*, 14(9), 761–776. <http://doi.org/10.1080/089419201753210585>
- Wynveen, C. J., Connally, W. D., & Kyle, G. T. (2013). Pro-environmental behavior in Marine Protected Areas : the cases of the Great Barrier Reef Marine Park and the Florida Keys National Marine Sanctuary. *Journal of Park and Recreation Administration*, 31(2), 28–49.

Table 3. 1. Definitions of Schwartz' basic value types and their hypothesized correlation with compliance with low impact recreation behavioral recommendations.

Value Type	Conceptual Definitions	Hypotheses
Self-direction -Thought	Freedom to cultivate one's own ideas and abilities	n.s.
Self-direction -Action	Freedom to determine one's own actions	-
Stimulation	Excitement, novelty and change	-
Hedonism	Pleasure and sensuous gratification	--
Achievement	Success according to social standards	-
Power -Dominance	Power through exercising control over people	n.s.
Power -Resources	Power through control of material and social resources	n.s.
Face	Security and power through maintaining one's public image and avoiding humiliation	n.s.
Security -Personal	Safety in one's immediate environment	+
Security -Societal	Safety and stability in the wider society	n.s.
Tradition	Maintaining and preserving cultural, family, or religious traditions	+
Conformity -Rules	Compliance with rules, laws and formal obligations	++
Conformity -Interpersonal	Avoidance of upsetting or harming other people	+
Humility	Recognizing one's insignificance in the larger scheme of the ingroup	n.s.
Benevolence - Dependability	Being a reliable and trustworthy member of the ingroup	n.s.
Benevolence -Caring	Devotion to the welfare of ingroup members	n.s.
Universalism -Concern	Commitment to equality, justice and protection for all people	n.s.
Universalism - Nature	Preservation of the natural environment	++
Universalism -Tolerance	Acceptance and understanding of those who are different from oneself	n.s.

Notes. + : The value was hypothesized to be positively correlated with compliance with low-impact recreation recommendations; Number of plus's or minus's suggest the magnitude of hypothesized correlation, with two signs indicating a moderate correlation and one sign indicating a weak correlation.
- : The value was hypothesized to be negatively correlated with compliance with low-impact recreation recommendations;
n.s.: The value is hypothesized to not be correlated with compliance with low-impact recreation recommendations.

Table 3. 2. Respondents' profile.

	Frequency	%
Gender:		
Female	385	31.9
Male	811	67.1
Self-specified ^a	8	0.7
Prefer not to disclose	4	0.3
Race: ^b		
American Indian or Alaskan Native	12	1.0
Asian American	17	1.4
Black or African American	2	0.2
Native Hawaiian or other Pacific Islander	2	0.2
White	1142	94.5
Age:		
Under 20	5	0.4
20-39	628	52.8
40-59	307	25.8
60 and over	249	20.9
Income:		
Less than \$20,000	259	21.4
\$20,000 to \$39,999	207	17.1
\$40,000 to \$59,999	162	13.4
\$60,000 to \$79,999	149	12.3
\$80,000 to \$99,999	93	7.7
\$100,000 or more	294	24.3

a. Examples of self-identified gender included husband and wife team, gender queer, and transgender.
 Other comments included “stop being so political correct, be yourself” and “well, this is a little too PC for me...” b. The percentages of racial groups did not add up to one, because some participants identified themselves with multiple racial groups.

Table 3. 3. Summary of respondents' values.

Value items	Mean	S.D.
<i>Self-direction- thought (Cronbach $\alpha = .602$)</i>		
Being creative is important to him/her/them	4.2	0.9
It is important to him/her/them to form his/her/their own opinions and have original ideas	4.5	0.5
Learning things for himself/herself/themselves and improving his/her/their abilities is important to him/her/them	4.7	0.6
<i>Self-direction – action (Cronbach $\alpha = .638$)</i>		
It is important to him/her/them to make his/her/their own decisions about his/her/their life	4.7	0.5
Doing everything independently is important to him/her/them	3.9	0.9
Freedom to choose what he/she/they does is important to him/her/them	4.6	0.6
<i>Stimulation (Cronbach $\alpha = .847$)</i>		
He/she/they is always looking for different kinds of things to do	4.4	0.8
Excitement in life is important to him/her/them	4.4	0.8
He/she/they thinks it is important to have all sorts of new experiences	4.5	0.8
<i>Hedonism (Cronbach $\alpha = .849$)</i>		
Having a good time is important to him/her/them	4.2	0.8
Enjoying life's pleasure is important to him/her/them	4.3	0.8
He/she/they takes advantage of every opportunity to have fun	3.7	1.0
<i>Achievement (Cronbach $\alpha = .638$)</i>		
He/she/they thinks it is important to be ambitious	3.9	1.0
Being very successful is important to him/her/them	3.9	0.9
He/she/they wants people to admire his/her/their achievements	3.5	1.1
<i>Power-resources (Cronbach $\alpha = .842$)</i>		
Having the feeling of power that money can bring is important to him/her/them	2.3	1.1
Being wealthy is important to him/her/them	2.2	1.0
He/she/they pursues high status and power	2.0	1.0
<i>Power-dominance (Cronbach $\alpha = .845$)</i>		
He/she/they wants people to do what he/she/they says	2.6	1.0
It is important to him/her/them to be the most influential person in any group	2.2	1.0
It is important to him/her/them to be the one who tells others what to do	2.1	0.9

Table 3.3. (Continued)

<i>Face (Cronbach $\alpha = .702$)</i>			
It is important to him/her/them that no one should ever shame him/her/them	3.1	1.1	
Protecting his/her/their public image is important to him/her/them	3.1	1.1	
He/she/they wants people always to treat him/her/them with high respect and dignity	3.7	1.0	
<i>Security-personal (Cronbach $\alpha = .764$)</i>			
He/she/they avoids anything that might endanger his safety	2.6	1.1	
His personal security is extremely important to him/her/them	3.4	1.1	
It is important to him/her/them to live in secure surroundings	3.0	1.1	
<i>Security-societal (Cronbach $\alpha = .816$)</i>			
It is important to him/her/them that his country protect itself against all threats	3.4	1.2	
He/she/they wants the state to be strong so it can defend its citizens	3.4	1.2	
Having order and stability in society is important to him/her/them	3.7	1.0	
<i>Tradition (Cronbach $\alpha = .886$)</i>			
It is important to him/her/them to maintain traditional values or beliefs	3.0	1.3	
Following his family's customs or the customs of a religion is important to him/her/them	2.6	1.4	
He/she/they strongly values the traditional practices of his culture	2.8	1.2	
<i>Conformity – rules (Cronbach $\alpha = .801$)</i>			
He/she/they believes he should always do what people in authority say	2.5	1.1	
It is important to him/her/them to follow rules even when no one is watching	3.8	1.0	
Obeying all the laws is important to him/her/them	3.5	1.1	
<i>Conformity – interpersonal (Cronbach $\alpha = .799$)</i>			
It is important to him/her/them to avoid upsetting other people	3.8	1.0	
He/she/they thinks it is important never to be annoying to anyone	3.5	1.1	
He/she/they always tries to be tactful and avoid irritating people	4.0	0.9	
<i>Humility (Cronbach $\alpha = .613$)</i>			
He/she/they tries not to draw attention to himself/herself/themselves	3.7	1.0	
It is important to him/her/them to be humble	4.2	0.8	
It is important to him/her/them to be satisfied with what he has and not to ask for more	3.9	1.0	

Table 3.3. (Continued)

It is important to him/her/them to be loyal to those who are close to him/her/them	4.6	0.6
He/she/they goes out of his way to be a dependable and trustworthy friend	4.6	0.6
He/she/they wants those he/she/they spends time with to be able to rely on him/her/them completely	4.4	0.8
<i>Benevolence-caring (Cronbach $\alpha = .835$)</i>		
It is very important to him/her/them to help the people dear to him/her/them	4.6	0.6
Caring for the well-being of people he/she/they is close to is important to him/her/them	4.6	0.6
He/she/they tries always to be responsive to the needs of his/her/their family and friends	4.5	0.6
<i>Universalism-concern (Cronbach $\alpha = .724$)</i>		
Protecting society's weak and vulnerable members is important to him/her/them	4.1	0.9
He/she/they thinks it is important that every person in the world have equal opportunities in life	4.1	1.0
He/she/they wants everyone to be treated justly, even people he doesn't know	4.6	0.6
<i>Universalism-nature (Cronbach $\alpha = .818$)</i>		
He/she/they strongly believes that he/she/they should care for nature	4.8	0.5
It is important to him/her/them to work against threats to the world of nature	4.3	0.7
Protecting the natural environment from destruction or pollution is important to him/her/them	4.5	0.7
<i>Universalism-tolerance (Cronbach $\alpha = .677$)</i>		
He/she/they works to promote harmony and peace among diverse groups	3.8	1.0
It is important to him/her/them to listen to people who are different from him/her/them	4.2	0.7
Even when he disagrees with people, it is important to him/her/them to understand them	4.3	0.8

Table 3. 4. Pearson correlation coefficients between values types and compliance with low impact recreation behavioral recommendations.

Value Type	Hypotheses	Cathole	Camping	Canister	Hanging
Self-direction -Thought	n.s.	0.08**			
Self-direction -Action	—				
Stimulation	—	-0.07*			-0.06**
Hedonism	—	-0.07*			
Achievement	—				
Power -Dominance	n.s.	-0.07*	0.10***		
Power -Resources	n.s.	-0.09**			
Face	n.s.				
Security -Personal	+				0.11***
Security -Societal	n.s.				0.15***
Tradition	+			0.08*	0.09**
Conformity -Rules	+	0.08**	0.08**		0.02***
Conformity -Interpersonal	+				
Humility	n.s.				
Benevolence -Dependability	n.s.				
Benevolence -Caring	n.s.				0.10***
Universalism -Concern	n.s.	0.12***			0.14***
Universalism - Nature	+	0.09**			
Universalism -Tolerance	n.s.				

***p-value< .001 ** p-value< .01 * p-value< .05

Table 3. 5. Model fit indices.

Models	χ^2	df	SRMR	RMSEA	CFI	TLI	AIC
<i>Dependent Variable: using catholes when privies/outhouses are not available.</i>							
Fully mediated simple model	2982.8	728	0.05	0.05	0.89	0.87	3332.8
Partial mediated simple model	2938.2	716	0.05	0.05	0.89	0.87	3312.2
Parallel complex model	5262.7	1308	0.05	0.05	0.85	0.83	5726.7
Chain complex model	5378.0	1335	0.06	0.05	0.84	0.83	5788.0
<i>Dependent Variable: camping only on previously used campsites</i>							
Fully mediated simple model	2182.5	528	0.05	0.05	0.91	0.89	2458.5
Partial mediated simple model ^a	1526.0	507	0.08	0.04	0.75	0.69	1844.0
Parallel complex model	4461.7	1034	0.06	0.05	0.85	0.83	4843.7
Chain complex model	4425.0	919	0.06	0.06	0.83	0.80	4949.0
<i>Dependent Variable: using a bear canister to store food and other smellable items</i>							
Fully mediated simple model	2219.8	440	0.05	0.06	0.89	0.87	2461.8
Partial mediated simple model	2215.8	431	0.05	0.06	0.89	0.86	2475.8
Parallel complex model	4321.8	909	0.05	0.06	0.84	0.82	4665.8
Chain complex model	4321.2	930	0.06	0.06	0.84	0.82	4723.2
<i>Dependent Variable: hanging food and other smellable items</i>							
Fully mediated simple model	3879.2	728	0.05	0.06	0.86	0.83	4229.2
Partial mediated simple model	3822.9	716	0.05	0.06	0.86	0.83	4196.9
Parallel complex model	6169.7	1308	0.06	0.06	0.83	0.80	6633.7
Chain complex model	6326.4	1335	0.07	0.06	0.82	0.79	6736.4

***p-value< .001 ** p-value< .01 * p-value< .05

Table 3. 6. Standardized path coefficients and R² for the fully mediated simple model for the recommended low-impact recreation behavior of digging a cathole when a privie/outhouse is not available.

Predictors	Estimate	S.E.	t-value	R ²
<i>Dependent variable: attitudes toward digging a cathole</i>				7.9%
Self-direction -Thought	0.11	0.10	1.1	
Self-direction -Action	-0.04	0.09	-0.5	
Stimulation	-0.12	0.09	-1.4	
Hedonism	0.16	0.08	2.1**	
Achievement	-0.18	0.08	-2.4**	
Power -Dominance	-0.11	0.04	-2.6**	
Power -Resources	0.15	0.06	2.5**	
Security -Personal	-0.05	0.04	-1.2	
Tradition	0.08	0.04	2.1	
Conformity -Rules	0.14	0.04	3.1***	
Conformity -Interpersonal	-0.12	0.04	-2.9***	
Universalism - Nature	0.16	0.04	3.6***	
<i>Dependent variable: behavioral compliance</i>				10.9%
Attitudes toward digging a cathole	0.33	0.03	11.66	

***|t-value|> 2.6, the critical value at 0.005 alpha level, ** |t-value|> 1.96, the critical value at 0.05 alpha level.

Table 3. 7. Standardized path coefficients and R² for the fully mediated simple model for the recommended low-impact recreation behavior of camping only on previously used campsites.

Predictors	Estimate	S.E.	t-value	R ²
<i>Dependent variable: attitudes toward camping only on previously used campsites</i>				5.0%
Self-direction -Action	0.03	0.05	0.6	
Stimulation	0.07	0.08	0.8	
Hedonism	-0.08	0.06	-1.3	
Achievement	0.01	0.06	0.2	
Power -Dominance	0.09	0.04	2.2 **	
Security -Personal	0.06	0.04	1.5	
Tradition	-0.02	0.04	-0.6	
Conformity -Rules	0.08	0.04	2.0 **	
Conformity -Interpersonal	0.03	0.04	0.7	
Universalism - Nature	0.15	0.04	3.9***	
<i>Dependent variable: behavioral compliance</i>				15.5%
Attitudes toward camping only on previously used campsites	0.39	0.03	14.9	

***t-value> 2.6, the critical value at 0.005 alpha level, ** t-value> 2, the critical value at 0.05 alpha level.

Table 3. 8. Standardized path coefficients and R² for the fully mediated simple model for the recommended low-impact recreation behavior of using canister to store food and other smellable items.

Predictors	Estimate	S.E.	t-value	R ²
<i>Dependent variable: attitudes toward using canister</i>				3.8%
Self-direction -Action	-0.02	0.05	-0.4	
Stimulation	0.03	0.08	0.4	
Hedonism	0.00	0.07	0.1	
Achievement	-0.06	0.05	-1.1	
Security -Personal	0.05	0.04	1.1	
Tradition	0.16	0.04	4.0***	
Conformity -Rules	0.03	0.04	0.6	
Conformity -Interpersonal	-0.02	0.04	-0.6	
Universalism - Nature	0.09	0.04	2.2 **	
<i>Dependent variable: behavioral compliance</i>				22.3%
Attitudes toward using canister	0.47	0.03	18.7***	

***t-value> 2.6, the critical value at 0.005 alpha level, ** t-value> 2, the critical value at 0.05 alpha level.



Figure 3. 1. The motivational circle of values according to the refined theory of basic values
adopted from Schwartz and Butenko. 2014

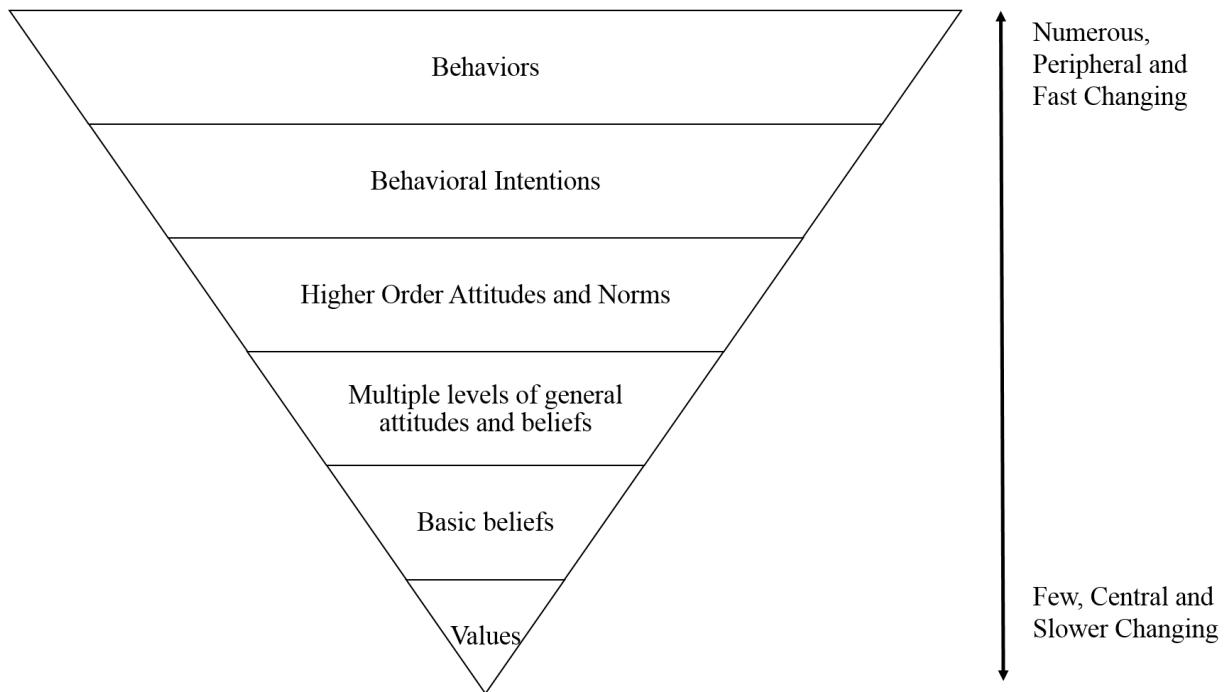


Figure 3. 2. The Cognitive hierarchy model of behavior (adopted from Perry-Hill et al., 2014)

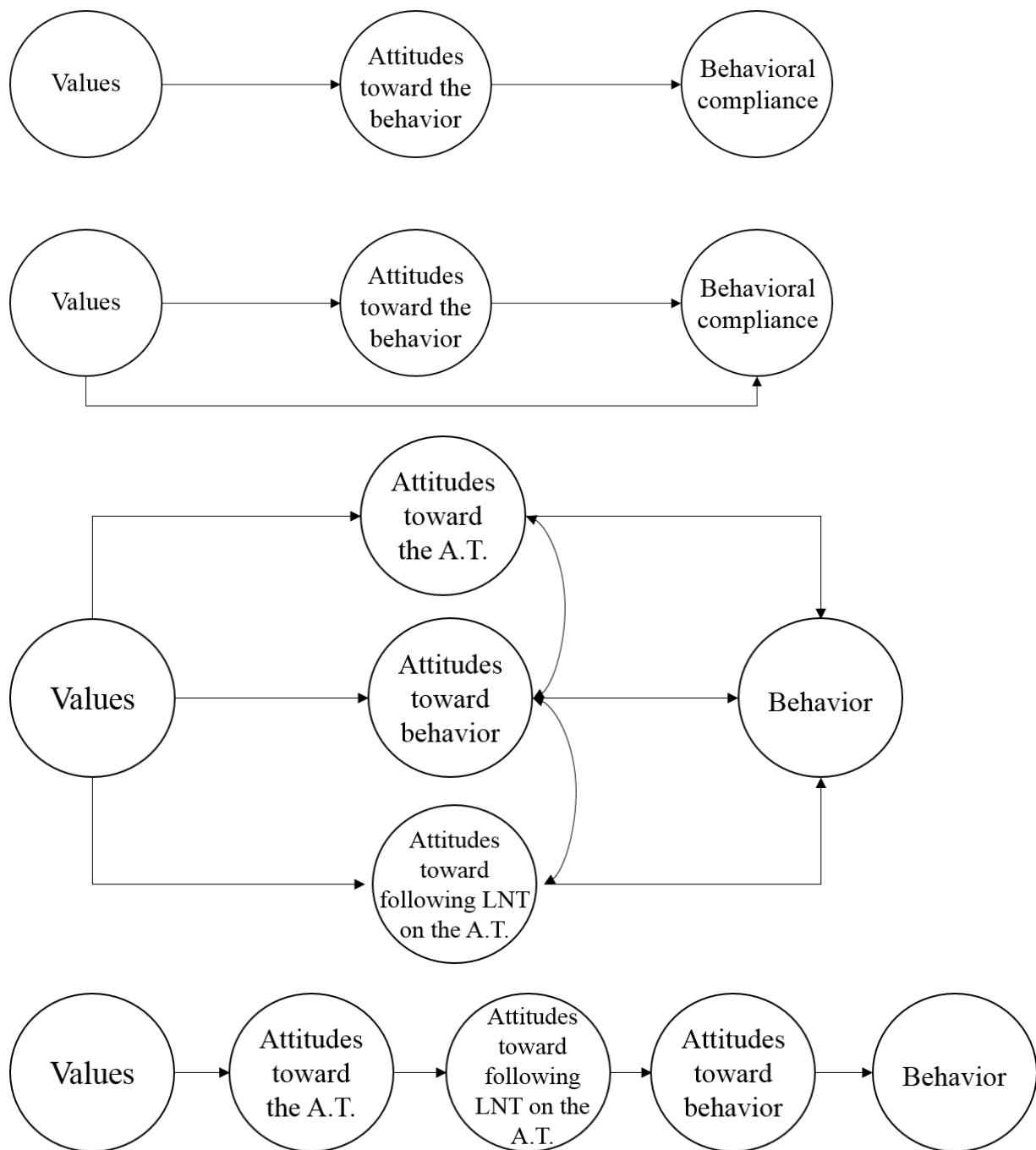


Figure 3.3. Conceptual framework of the value-attitude-behavior mediation models. The mediation models include: 1) a fully mediated simple model; (2) a partially mediated simple model; (3) a parallel complex model; and (4) a chain complex model.

CHAPTER 4: DOES THE TIMING OF EDUCATIONAL MESSAGING INFLUENCE COMPLIANCE WITH LOW-IMPACT HIKING RECOMMENDATIONS?

Abstract

We examined how the timing of educational messaging influences individuals' compliance with, knowledge about, and attitudes towards two low-impact hiking recommendations (i.e., hiking on muddy trail sections and walking on trail steps rather than around them) using a lab-based experiment. The educational message used in the experiment consisted of a video and short summary statements about low-impact hiking recommendations. Forty-seven participants were randomly assigned to one of three groups: 1) viewing the message at least 24 hours before the experiment; 2) viewing the message immediately before the experiment; or 3) not viewing the message at all (control). We assessed participants' hiking intentions by asking them to draw their intended hiking routes on a large LCD display depicting short sections of the Appalachian Trail. Participants' intended routes were coded as either complying or not complying with low-impact hiking recommendations. For participants who received the educational message, knowledge about and attitudes toward low-impact hiking were measured twice, immediately after viewing the message and at the end of the lab-based experiment. Our analyses revealed the educational message significantly improved participants' intentions to comply with low-impact hiking recommendations, knowledge levels, and attitudes. The timing of when the educational message was viewed/read by participants, however, did not influence their intentions to comply, knowledge levels, or attitudes. These findings suggest compliance with low-impact hiking recommendations can be influenced through educational messages delivered before outdoor recreationists begin their trips.

Keywords: timing; educational message; low-impact hiking behaviors; retention; laboratory-based experiment

Introduction

Natural resource managers are often tasked with reducing the environmental impacts caused by recreationists. Recreation impacts include, but are not limited to, soil compaction, vegetation trampling, wildlife disturbance and degraded water quality. Each of these impacts challenges the ability of natural resource managers to simultaneously protect natural resources and provide desirable recreation opportunities (Marion et al., 2016). Visitor education and information programs are some of the most commonly used indirect management approaches (i.e., ones that indirectly influence visitor behavior as opposed to direct management approaches such as rules, regulations, mandatory permits or restrictions on length of stay) (Manning, 2011). Using on-site signs, posters, interpretation, personal contact and other communication tools, visitor information and education programs can be effective in educating visitors about appropriate recreation behaviors, increasing awareness of recreation impacts, and promoting positive attitudes toward low-impact recreation practices (Marion & Reid, 2007). However, with steadily growing visitation levels at many outdoor recreation destinations, it is becoming increasingly difficult for visitor information and education programs to reach the increasing number of visitors (Jacobi, 2003). This is especially true given the diverse number of ways (e.g., via social media) that visitors can now learn about outdoor recreation opportunities and settings (National Parks Conservation Association, 2009). Visitor education programs that rely solely on on-site communication may no longer be sufficient to deal with larger volumes of visitors who have an abundance of highly diverse information streams at their disposal.

Outdoor recreationists who are poorly informed about responsible recreation behavior before they arrive at their destination are likely to be either ill-prepared to recreate in an environmentally-responsible manner (e.g., not bringing the gear necessary to dispose of waste properly) or simply be unaware of what responsible recreation behaviors are. Either of these situations are likely to lead to depreciative recreation behaviors, such as crossing safety barriers to hike in hazardous areas (Hayes, 2008; Reigner & Lawson, 2009). It is unlikely that on-site signage alone will dissuade recreationists from visiting sought after parts of destinations they have traveled long distances to experience (Hayes, 2008). Previous research suggests visitor information and education programs are more effective when delivered early in the overall recreation experience such as during trip planning (Manning, 2011; Marion, 2014). Such off-site visitor education programs need to be proactive in how they target and communicate with prospective outdoor recreationists.

Reaching visitors before they arrive at a destination is not a new concept for outdoor recreation planners, resource managers, or environmental educators. Doucette and Cole (1993) suggested wildland managers use commercial television and radio to educate wilderness visitors. Manfredo and Bright (1991) examined individual responses (e.g., number of thoughts generated, acquisition of new beliefs and changes in old beliefs) to a mailed pre-trip information package about policies and responsible behaviors at the Boundary Waters Canoe Area Wilderness. Similarly, Bromley, Marion, and Hall (2013) as well as Daniels and Marion (2005) found experiential training programs developed by the Leave No Trace Center for Outdoor Ethics left lasting and positive effects on participants' attitudes toward and compliance with Leave No Trace principles. However, most of these training programs tended to last multiple days and require substantial time commitments from participants.

Web-based technologies such as social media and emails provide promising avenues for visitor education (National Parks Conservation Association, 2009). Compared to traditional communication tools, electronic communication can deliver educational messages with images and videos that directly demonstrate responsible recreation behaviors. The Leave No Trace Center for Outdoor Ethics offers an online awareness course, aside from the aforementioned experiential training programs, that outdoor recreationists can participate in from the comfort of their own homes, but their usage and effectiveness have not been systematically evaluated. Natural resource managers, such as the National Park Service, have showed a growing interest in reaching out to constituents through online communication channels such as emails and social media (National Parks Conservation Conservation, 2009). Through online pre-trip registration and permitting efforts, such as the Appalachian Trail Conservancy's voluntary long-distance hiker registration system, natural area managers do have the ability to directly target and communicate with future visitors. Off-site education programs can also help reduce the need for on-site infrastructure and materials such as signs or brochures as well as personnel such as rangers and interpreters tasked with educating the public about responsible recreation behavior. Labor costs are often among the most substantial and significant in terms providing outdoor recreation opportunities (Siderelis et al., 2012).

Despite the opportunity of using web-based technologies to educate visitors prior to their trips, little is known about how to effectively develop off-site, low-impact recreation behavior educational messages. One particular challenge facing off-site education programs is the delay between when individuals receive an educational message and when they arrive on-site and face situations where they must choose to comply with low-impact recreation recommendations or not. For some low-impact recreation recommendations such as wildlife feeding or hiking off

designated trails, educational messages may be more effective when delivered as closely as possible to the occurrence of the targeted behaviors (Manning, 2011; Bradford & McIntyre, 2005). Empirical research is needed to evaluate the effect of visitor education messaging timing on behavioral change.

Theoretical Background

There are two well-documented lines of research in social-psychology that can be applied to help explain the potential effects of educational messaging timing on individual compliance with low-impact recreation behavioral recommendations: 1) the forgetting-curve hypothesis based on Ebbinghaus' (1913) classic memory theory; and 2) the stable-attitude hypothesis based on the Theory of Planned Behavior and the Elaboration Likelihood Model (cited in Eagly and Chaiken, 1993a).

The forgetting-curve hypothesis suggests the longer the time between when a message regarding low-impact recreation behavioral recommendations is delivered and when the targeted recreation behavior occurs, the less likely individuals will be to change their behaviors. This hypothesis is based on Ebbinghaus' negatively accelerating forgetting curve concept, which posits that as time passes, individuals forget much of what they learned when reading or viewing an educational message (cited in Eagly and Chaiken, 1993a). A variety of classic (e.g., Miller & Campbell, 1959; Watts & McGuire, 1964) as well as recent (e.g., Erdelyi, 2010; Murre & Dros, 2015) studies have supported Ebbinghaus' forgetting curve concept.

By comparison, the stable-attitude hypothesis suggests that if an educational message is able to change individuals' attitudes, those attitudes will remain stable and continue to influence behaviors into the future. The stability of altered attitudes will continue to influence behavior long after individuals forget the educational message. This hypothesis is supported by the Theory

of Planned Behavior in which attitudes toward a behavior are a major determinant of volitional behavior (Eagly & Chaiken, 1993c). The hypothesis is also supported by the Elaboration Likelihood Model which proposes attitudinal changes result in temporally-persistent influences on better behavior (Eagly & Chaiken, 1993b). Compared to the forgetting-curve hypothesis, the stable-attitudes hypothesis posits the stability of attitudes could overcome the effects of individuals' tendency to forget the content of educational messages as it becomes more temporally remote.

There are very few empirical studies related to these two opposing hypotheses that examine low-impact recreation behavior. In terms of the forgetting curve hypothesis, Manfredo and Bright (1994) found that 76% of visitors to a Wilderness area in Minnesota recalled receiving an information packet sent by a land management agency prior to taking their trip, and 41% of these visitors indicated the information package changed some of their old ideas regarding Wilderness use. However, only 11% indicated their behavior changed as a result of the information. Manfredo and Bright's work suggests visitors might be able to recall the off-site educational message, but also indicates recall alone is not necessarily enough to change recreationists' behaviors. Bradford and McIntyre (2005) tested how the locations of educational messages as well as the message content influenced visitors' off-trail hiking behavior. They found the message that attributed local environmental problems to recreation activities located at undesignated trail sites was most likely to reduce off-trail use, compared to the same message presented at an information booth or a simple message located along an undesignated trail telling visitors not to hike off-trail. Bradford and McIntyre did not report how far the information booth was from the undesignated trail sites, but it seems reasonable to assume that for participants who

received the educational message via the information booth, there was a temporal delay between when the message was received and when the off-trail hiking behavior occurred.

In terms of the stable-attitude hypothesis, the effects of attitudes on low-impact behavior have been widely examined. However, much less research has been conducted on how attitudes change over time. A recent review of the literature found attitudes (most often attitudes towards a specific recreation behavior) to be the most studied social-psychological construct used to predict compliance with low-impact recreation behavioral recommendations (See Chapter Two of this dissertation). The attitude-behavior relationship within the context of low-impact recreation behavior has been supported using cross-sectional data and regression analysis as well as structural equation modeling (Lawhon, 2013; Vagias et al., 2014). Researchers have also developed behavioral change interventions based on the Theory of Planned Behavior and were able to increase compliance with targeted low-impact recreation recommendations (Brown et al., 2010; Hughes et al., 2009; Reigner & Lawson, 2009). For example, Brown et al. (2010) used a three-step method (solicit salient beliefs—select most influential beliefs—develop messages targeting the selected beliefs) to create two educational messages encouraging picking up litter. They found with one message, 36.6% of visitors picked up a can planted by the researchers, while with the other message, 31.7% picked up the can, both much higher than the 17.4% pick-up rate under the control condition. Visitors who received the messages also reported more positive attitudes toward setting a good example for others.

Fewer studies have tested the Elaboration Likelihood Model of persuasion in the context of low-impact recreation behavior using cross-sectional data; the studies that have been completed show mixed results. Manfredo and Bright (1991), in their aforementioned study, found the number of thoughts generated by visitors about the information package moderately

predicted the acquisition of new beliefs ($\beta = 0.43$) and changes to prior beliefs ($\beta = 0.27$), which then significantly predicted self-reported behavior change ($\beta = 0.59$ for acquisition of new beliefs, $\beta = 0.11$ for change of prior beliefs). Conversely, Jones (2004) found the time individuals spent thinking about a specific behavior as well as the number of reasons they could list to adopt the behavior (two measures commonly used to operationalize the Elaboration Likelihood Model) were not significant predictors of a variety of Leave No Trace behaviors. One exception was the behavior of staying on the designated trail, for which the regression coefficient associated with thinking-time was significant (p -value = 0.027), but the effect was in the opposite direction as what would be expected under the Elaboration Likelihood Model ($\beta = -0.031$). In other words, the more individuals thought about staying on the trail, the less likely they were to actually do so. We did not find sufficient empirical evidence in the literature to support either hypothesis about how the timing of educational messages might influence low-impact recreation behavior.

In this study, we also used McGuire's (1968) information process paradigm to develop a behavioral change intervention. McGuire proposed the persuasive impact of messages can be viewed as the multiplicative product of six information-processing steps: 1) presentation; 2) attention; 3) comprehension; 4) yielding; 5) retention; and 6) behavior. Any failure in this chain of responses causes the sequence to be broken, and consequently, no behavioral change to occur. The timing of educational messaging, which is of central interest to this current study, directly influences the retention step, that is, how long message recipients need to retain the information provided in the message and hold their induced attitudes stable. To test the effects of retention, it is important to control for the prior steps (i.e., attention, comprehension, and yielding) through experimental design, well-developed measurement items, and statistical controls.

In summary, previous research has rarely tested whether the timing of educational messages influences low-impact recreation behaviors. It is unclear whether the temporal delay between message delivery and behavior follows the forgetting curve, leading to increasingly marginal behavioral changes as time increases. Or, conversely, can educational messages alter individual attitudes enough to alter future recreation behavior? Given this, our study set out to examine whether or not when an educational message is received influences individuals' knowledge about, attitudes toward, and compliance with low-impact hiking recommendations. Specifically, we compared the effects of Leave No Trace hiking messages delivered immediately before or more than 24 hours before participating in a lab-based experiment. The experiment gauged individuals' behavioral intentions when placed in a hypothetical hiking situation as well as their knowledge of, and attitudes toward specific low-impact hiking behaviors. Collectively, our research questions were:

RQ 1: Does the timing of a low-impact hiking educational message influence individuals' compliance with low-impact hiking recommendations?

RQ 2: Does the timing of a low-impact hiking educational message influence individuals' knowledge levels and retention of the information received through that message?

RQ 3: Does the timing of a low-impact hiking educational message influence individuals' attitudes towards low-impact hiking behaviors?

Methods

Study Design

This study used an experimental design with two treatment groups and a control group to test the effects of the timing of an educational message on: 1) individuals' compliance with low-impact hiking recommendations; 2) their knowledge level and retention of information received

through the educational messages; and 3) their attitudes towards low-impact hiking behavior. Data were collected via a pre-survey, a lab-based simulation, and a post-survey. The pre-survey, administered immediately *after* participants viewed the educational message, solicited information on individuals' knowledge of low-impact hiking recommendations as well as their attitudes towards low-impact hiking behaviors (Appendix F). The lab-based simulation involved presenting photos of actual trail segments with degraded conditions to participants in a controlled setting and asking them to indicate how they would navigate that segment if confronted with those conditions on an actual hike (Appendix G). The post-survey, administered after the experiment, was used to reassess individuals' knowledge of low-impact hiking recommendations as well as their attitudes towards low-impact hiking behavior; the post-survey was also used to collect data on participants' sociodemographic characteristics and levels of backcountry and hiking experience.

Participants.

Participants were undergraduate students at a major U.S. research university. All participants were taking courses related to parks, recreation, sports or tourism management at the time of data collection. Nine instructors were contacted and all agreed to allow their students to participate. Five instructors provided modest extra credit points to participants although the researcher did not request this. Institutional Review Board approval for the study was obtained before contacting instructors. Interested students signed up with their names and email addresses after an in-class presentation about the study. A follow-up email was sent to students who signed up asking them to schedule a time to participate in the lab-based portion of the study. Another six email reminders were sent to interested students who had yet to schedule a time to participate in the lab-based portion of the study between April 9th and 25th, 2016. A total of 121 students

signed up after the in-class presentations; five students dropped out due to various reasons (e.g., a lack of time, health issues, etc.). Another nine students scheduled a lab session, but did not show up. A total of 40 students did not schedule a lab session. A total of 67 students participated in the lab portion of the study¹⁹. Unfortunately, this number of participants did not reach our desired sample size calculated prior to participant recruitment and randomization using the PROC POWER procedure in SAS version 9.4 under conservative assumptions of power and effect size.²⁰ Limitations and reasoning related to sample size are discussed later.

¹⁹ Among these participants, 88% were from courses that gave extra credit points as incentives. The approximate sign-up rate was 32%, which was calculated by the number of signed-up students divided by the estimated total number of students in the nine courses. The participation rate was 55%, which was calculated by the number of actual lab session participants divided by the total number of students who signed up. The low sign-up and participation rates might have been due to the fact the experiment was conducted two weeks before final exams. There were also two other experiments recruiting student participants at the same time competing for students' time and interest. Moreover, to comply with IRB requirements, study communications did not mention the extra credit opportunities that some instructors chose to provide. The initial and reminder emails focused on the importance of the study's managerial implications and the value of student participation in helping the researcher. The participation rate for incentivized courses was 64.8%, compared to the 30% for not-incentivized courses.

²⁰ The goal of the sample size calculation was to determine the number of participants that would be needed to achieve a power of 0.8 following the convention of clinical trials (FDA, 1998) and at a 0.1 significance level for Type I error and Type II error which are also considered to be important (SAS Institute Inc., 2016). The compliance rates with Leave No Trace hiking principle were predicted to increase from 20% of the control to 50% of the treatment group receiving the educational message off-site (odds ratio=4), and from 50% of the three-day treatment group to 80% of the immediate treatment group (odds ratio=0.25). Under these assumptions, sample sizes were calculated for the two pairs of comparison (control vs three days, and three days versus immediately). The desired sample size was estimated to be 30 participants for each group (i.e., targeting 90 participants in total). These effect size assumptions were made based on a judgment about what the minimal difference in treatment effects would be to make the treatment practically relevant in visitor education. In other words, in situations similar to the hiking situations this study simulated (i.e., challenging trail conditions for Leave No Trace compliance), we consider an educational message that increased the Leave No Trace hiking compliance rate by 30% compared to no message effective, and an off-site education message that increased the compliance rate by 30% compared to an on-site educational message to be worthy of management investment. Under that set of assumptions, power was not expected to detect any increase in compliance rates from control to the off-site group by lower than 30%. Similarly, the power was not expected to detect any decreases in the compliance rates from the on-site to the off-site message by more than 30%. Additionally, sample sizes were calculated for a variety of deviations from the reported set of assumptions. The desired sample sizes we calculated for each treatment groups were found sensitive to effect size assumptions. Unfortunately, there were no published data or results from earlier studies to provide direct references. The desired sample sizes were used to generally guide the number of instructors I contacted and the number of reminders emailed.

Experimental design.

A Random Block Control Design was used to assign participants to three groups, two experimental groups and a control. The two experimental groups were designed to either receive an email with the educational message three days before the experiment (Group 1) or receive the educational message in the lab immediate before the experiment (Group 2). The Control group did not receive the educational message. Acknowledging that students assigned to Group 1 might not respond to the educational message and pre-survey on time, which would decrease the number of participants in this group, we assigned unequal random selection probabilities across the three groups. The probabilities used to allocate participants were 0.6 for Group 1 (i.e., receiving an educational message at least 24-hours before the experiment), 0.2 for Group 2 (i.e., receiving the educational message immediate before the experiment) and 0.2 for the Control group.²¹ A total of 64 individuals were assigned to Group 1, 28 to Group 2, and 28 to Group 3.

Materials and Measures

Educational message.

We designed an educational message to inform participants about low-impact hiking behaviors under two types of degraded trail conditions. The first condition was a muddy and wet trail and the second was a steep trail with management-installed steps and user-created routes

²¹ For example, if 37 students signed up from a participating course, about 60% of them (n=21 after rounding) were randomly assigned to the treatment level one group, 20% (n=8) were randomly assigned to the immediately prior message group, and 20% (n=8) were randomly assigned to the no-message group. The unequal probabilities were calculated using information about how many students responded on time to the first round of scheduling emails. After students initially signed-up for the study, they were sent emails with a link for them to schedule a time to come to the lab. A reminder was sent one day after the initial email. About 34% of participants responded to the first round contacts and scheduled times to come to the lab, suggesting for every participant who would actually view treatment 1, at least three participants would need to be contacted. To match the number of people who would actually receive treatment 1, there would need to be three assigned to treatment 2, and one assigned to the control. Thus, out of 5 people, 3 people were assigned to treatment 1 (probability = 0.6), one person assigned to treatment 2 (probability = 0.2, and one assigned to control (probability = 0.2).

around the steps. The goal of the educational message was to inform participants that when encountering muddy trails or user-created side trails, the desired hiking behavior is to walk through the mud or use the steps to avoid widening the trail.

The educational message consisted of a video followed by short written statements about desirable hiking behaviors when encountering degraded trail conditions. The selected video was part of a *Don't be that Guy* series developed by the Appalachian Trail Conservancy in 2015 to promote Leave No Trace principles on the Appalachian Trail. The video focused on the Leave No Trace principle of "travel and camp on durable surfaces" and lasted 89 seconds²². The story line involves an individual (i.e., "that guy") who unintentionally generates environmental impacts along the Appalachian Trail by not following Leave No Trace guidelines. The video shows the environmental impacts of certain hiking and camping behaviors with examples and humor.

Three short statements about walking through mud on trails and walking on steps rather than around them were listed immediately after the video (the statements are presented in Figure 1 along with a screenshot from the educational video). Two statements were rephrased slightly from those presented in the video about walking through mud on trails. The third statement was about walking on wood or stone steps rather than around them, which was not presented in the video. Information from the Appalachian Trail Conservancy's Leave No Trace campaign and the educational materials from the Leave No Trace Center for Outdoor Ethics were used to develop the statements. Experts in Leave No Trace and trail maintenance reviewed the statements. The statements were pilot tested with five reviewers to ensure they were clear and unambiguous. The video and statements were compiled as part of the study pre-survey.

²² Video Link:
<https://www.youtube.com/watch?v=SLhFAuKsGuk&list=PLuekIhaoBuWZ0c4R2jd3RE4PgjDwg9NOp&index=5>

Knowledge and attitudes.

In Group 1 and Group 2, participants' knowledge and attitudes about low-impact hiking behaviors were measured through both pre- and post-surveys administered on either end of the lab-based portion of the study. The pre-survey was administered immediately after the educational messaging was viewed/read, and the post-survey was administered immediately after participants completed the lab-based portion of the study.

During the pre-survey, participants were asked to select hiking behaviors that were recommended in the video and statements they were just exposed to (i.e., knowledge) using a "check all that apply" question with three options: 1) "if there is a mud puddle in the middle of the trail, get muddy and walk right through it"; 2) "if you encounter wood or stone steps, walk on them rather than around them"; and 3) "if the trail is not totally dry, choose the wet part to step on rather than walking on dry barren soil or grasses along the edges". These options were phrased slightly differently from the statements in the educational message to test participants' comprehension. All the behaviors described in the statements followed Leave No Trace hiking recommendations and, if participants comprehended the educational message, they should have selected all three options. The first two statements were directly recommended in the educational message and corresponded to the trail conditions presented in the photos participants would see during the lab-based portion of the study. The third statement involved an inference from information in the video and statements. Word choices were guided by education campaigns from the Leave No Trace Center for Outdoor Ethics. Data were recorded as three binary variables, one for each statement (1 = the participant selected the behavior as recommended in the video; 0 = the participant did not select the recommended behavior).

After the knowledge questions, we measured attitudes toward two low-impact hiking behaviors: 1) “Walking through any puddles, mud, or rugged spots on the trail, rather than walking around them”; and 2) “Walking on wood or rock steps rather than around them”. The attitudes were measured through six semantic differential scales intended to elicit a wide range of attitudinal responses. The seven-point bi-polar scales included the following anchors: good-bad; wise-foolish; pleasant-unpleasant; easy-hard; convenient-tiresome; and necessary-not necessary. The anchor words were adapted from Ajzen (2001).

For participants who were assigned in Group 1, the pre-survey was administered through an online questionnaire delivered via emails. Participants who were assigned in Group 2 completed the pre-survey on a laptop in the lab immediately before viewing trail images. Participants in the Control group did not take the pre-survey. The post-survey with the same knowledge and attitudes scales was administered in the lab immediately after participants completed the lab-based portion of the study. Participants in the Control group also completed the post-survey; however instead of asking them to recall information provided in the educational messages, participants in the Control group were asked to select the hiking behaviors recommended by the Appalachian Trail Conservancy. The comparisons of the knowledge and attitudes collected via both the pre- and post-surveys were used to infer knowledge retention and attitude stability. The post-survey also included questions about participants’ demographic characteristics, their frequency of hiking, their level of backcountry experience, and their experience with hiking on the Appalachian Trail.

Lab-based simulations.

Trail photos were used to simulate hiking settings so that participants could choose which part of the trail they would use if actually hiking through that section of trail. All photos were

taken by one of the researchers on sections of the Appalachian Trail in Great Smoky Mountains National Park in North Carolina and Tennessee. The photos depicted two types of degraded trail conditions, either muddy trails or steep trails with wood or rock steps and user-created routes around the steps, corresponding to the educational message. A final set of seven photos, with four mainly characterized by muddy trails and three by steps, were used in the lab-based portion of the study (Figure 2). The photos provided a clear focus on the trail corridor without visual distractions such as human figures or overly shaded areas.

Once participants completed the informed consent form and the pre-survey (for participants in Group 2) in the lab, they were guided to a position about 4-feet from a 60-inch LCD display with touch screen functionality (For positions of the researcher and participants see Appendix H). Participants were first asked to practice drawing routes on two non-study trail images while imagining they were actually hiking on the trail depicted in the image. Participants were encouraged to step back and forth to get a full view of the photos. After participants indicated they understood the task, the following narrative description of a hypothetical hiking experience was read and presented (on screen) to them:

It is a sunny Saturday afternoon in mid-March. You are hiking on the Appalachian Trail in Great Smoky Mountains National Park carrying a light backpack and wearing hiking boots. It snowed earlier this week, but the temperature has risen to about 60 degrees.

The description was intended to give necessary contextual information about the simulated hiking trip. The time and temperature descriptions matched the conditions under which the photos were taken. The description about carrying a light backpack and wearing hiking boots was added to control for the variability in hiking intentions not caused by the treatment, but by how participants imagined their hiking experience.

Participants' hiking intentions were measured by asking them to indicate the route they would take on each of the seven trail images by using their finger to trace that route directly on the screen. Participants were encouraged to draw the routes they truly would take if they were hiking on the trail section in question. There were no restrictions about where they could draw their routes. This task took about three to four minutes to complete for all of the images. Before the session concluded, participants were instructed to sit back down and complete the online post-survey using the same laptop used for pre-survey.

Data Analysis

Coding.

Prior to coding, each of the original seven trail photos was marked with a low-impact hiking corridor consistent with the recommendations made in the video message. The corridors were developed by one of the authors who had extensive experience in trail management, visitor behavior and outdoor recreation research. We also checked the corridors with another Leave No Trace expert not directly involved in the project. The lines delineating the corridor were only used for coding and were not visible to participants. The corridor was delineated with boundaries at the left, right, and top of the photo. The top boundary for each photo was set to avoid the parts of the photos with low resolution or where curves in the trail might obscure participants' view of the main route. Consistent with low-impact use guidelines, the left and right boundaries were set to avoid undisturbed soil and vegetation, and areas of the trail that showed only slight signs of visitor impact, indicating where impacts might be just beginning.

Participants' intended hiking behaviors were initially coded as: 1) full compliance; 2) mostly compliant; 3) mostly non-compliant; or 4) full non-compliance. When the line a participant drew fell completely inside or outside of the low-impact hiking corridor, the intended

hiking behavior was coded as either full compliance or full non-compliance, respectively. When the drawn lines crossed over the boundaries of the low-impact-hiking corridor, the behavior was coded as either mostly compliant or mostly non-compliant based on the proportion of the drawn line that fell inside or outside the low-impact hiking corridor and the level of likely impact expected where the line was drawn.

For data analysis, behavioral responses were collapsed into two categories with the first consisting of full compliance and mostly compliant intentions and the second consisting of mostly non-compliant and fully non-compliant intentions. Changing the hiking intention into a binary variable enabled more interpretable analyses and helped mitigate possible concerns over low counts in any one of the behavioral response options (which could potentially bias results).

To improve impartiality and avoid coding errors, a single-blind approach was used in coding (Schulz and Grimes 2002). One of the authors with extensive trail knowledge and who was unaware of the treatment assignments for participants coded the routes drawn on the photos. Additionally, all photos were randomly ordered to avoid the coder potentially memorizing participants' earlier performance and thus introducing bias.

Treatment check.

Participants in Group 1 received the educational materials via emails. To check if the participants actually watched the video, the time participants spent on the pre-survey was examined. An embedded function in Qualtrics recorded how many seconds passed before the respondent clicked anywhere in the questionnaire page and how many seconds passed before the respondent clicked the last time (not including clicking the “Submit” button). The difference between the two measures gave the length of time a participant spent completing the pre-survey. The same data collected from participants in Group 2 were used to establish cut-off criteria.

Because this group of participants received the educational message at the lab, the length of time they took to complete the pre-survey was considered a good measure of the actual time needed.

The length of time used by participants in Group 2 to complete the pre-survey ranged from 80.3 to 607.5 seconds, with a mean of 157.2 seconds (95% CI, 94.0 to 220.5). The minimum length of time (80.3) was selected as the cut-off criteria.²³ Seven participants in Group 1 who spent less than 80.3 seconds completing the pre-survey were deemed not to have taken the necessary time needed to view and comprehend the educational messages presented; their responses were excluded from the analyses examining treatment effects.

Two participants indicated they had watched the video before the pre-survey; these participants were excluded from the analysis to keep the treatment consistent. Another 11 participants assigned to Group 1 were excluded from the analysis because they did not view/read the educational message at all or view/read the message on the same day they came to the lab. A total of 20 participants were excluded from the analysis, leaving a sample of 47 participants.²⁴

²³ The length of time boundary is considered reasonable from another perspective as well. The video lasted 89 seconds, but the materials relevant to hiking ends at the 44th second. The rest of the video was about camping which was not examined in this study. The time to finish the questionnaire varied depending on individual's reading speed and familiarity with taking surveys. Considering the length of the pre-experiment survey (four questions) and all participants in the immediate group having watched the video and read the statements, it was reasonable to use 80 seconds as the excluding criteria.

²⁴ Before excluding cases from the analysis, we tested the effects of four indicator variables and one continuous variable on the compliance with low-impact recreation behavior, including 1) whether the participant reviewed the educational message and finished the pre-test in less than 80.3 seconds, 2) whether the participant viewed the educational video before or not, 3) whether the participant received the educational message on the same day as the experiment, 4) whether the participant was originally assigned to group 1 but reassigned to group 2 or 3 because they did not view the educational message prior to the experiment as requested, and 5) how many days before the experiment the participants received the educational message. None of these variables were significant except for whether the participation received the educational message on the same day ($Beta = 1.78$, p -value = 0.0497). This means that within Group 1 participants receiving an educational message on the same day as the experiment were more likely to comply with low-impact hiking behavior compared to those who received the educational message at least 24 hours prior to the experiment. This finding contradicts our concern that individuals who were not able to follow experiment instructions would be less likely to comply with low-impact hiking behavior. To keep the data consistent with our experimental design, we decided to exclude these 20 cases from data analysis. However this result indicated that the exclusion of these cases did not bias the findings.

Analysis.

The final data set for analysis included 47 participants with 18 participants in Group 1, 16 participants in Group 2, and 13 participants in the Control group. Within Group 1, seven (38.9%) viewed/read the educational message three days before the lab-based portion of the study, three (16.7%) viewed/read the educational message two days before the lab-based portion of the study and seven (38.9%) viewed/read the educational message one day prior to the lab-based portion of the study. Analyses were conducted using SAS version 9.4.

For RQ 1, we analyzed the influence of educational message timing on participants' behavioral intentions with two mixed-effects logistic models using the PROC GLIMMIX procedure. The response was a binary variable for all models with "1" indicating "compliance with low-impact hiking recommendations" and "0" indicating "non-compliance with low-impact hiking recommendations". The first model included treatment as a fixed-effect and photo and participant as random effects. The second model added variables that might confound the treatment effects, including participants' hiking frequency, level of backcountry experience, Appalachian Trail hiking experience, and age. The same model was fit only to participants in Group 1 and 2 to test the effects of timing.

For RQ 2, we analyzed the influence of educational message and its timing on participants' knowledge level and retention of information using mixed-effects logistic regression models with knowledge level as the response, treatment group as a fixed-effect, and participants and knowledge statements as random effects using the PROC GLIMMIX procedure. The responses in all models were binary, with "1" indicating the participant knew the stated hiking behavior was recommended and "0" indicating they did not know the statement depicted a low-impact hiking behavior. The first model compared the post-survey knowledge indicators

among all three groups to examine the overall effect of the educational message on knowledge level. The second model was also fit to post-survey data but focused only on participants from Group 1 and 2 to address the timing effect on knowledge levels. Using data from both pre- and post-surveys, the third mixed-effect logistic regression model examined the retention of information from pre-survey to post-survey for participants in Group 1 and Group 2.

For RQ 3, we analyzed the influence of educational message timing on attitudes towards low-impact hiking behaviors through MANOVAs and one-way ANOVAs for each behavior using the PROC GLM procedure. For the MANOVA models, the six attitude measures collected in the post-survey were the multivariate response and treatment group was the factor. Additionally, one-way ANOVAs with post-hoc analyses were conducted for each attitude measure collected in the post-survey (e.g., good-bad; wise-foolish; pleasant-unpleasant; easy-hard; convenient-tiresome; and necessary-not necessary). The stability of attitudes was tested using MANOVAs with repeated measures. Additionally, 24 paired t-tests were conducted to compare the pre- and post-survey attitudes scores (two types of trail conditions × six attitude measures × two treatment groups). Bonferroni multi-comparison adjustment was used.

Results

Participants' Profiles

Of the 47 participants included in the analysis, the majority were female (61.7%), white (93.6%), and had an average age of 21.6 (Table 4.1). About half (51.1%) of participants included in the analysis indicated they hiked, walked, or ran on unpaved trails between one and five times a year, followed by 31.9% of participants who indicated hiking, walking, or running on unpaved trail more than 10 times a year (Table 4.1). Two participants (3.4%) reported they had never hiked, walked, or run on unpaved trails. On average, participants rated their levels of

backcountry experience towards the novice end of the scale ($\bar{x} = 3.2$, SD = 1.7, on a seven-point scale, 1 = novice, 7 = expert). About 57.4% of participants had not hiked on the Appalachian Trail. Of the 17 participants who had hiked on the Appalachian Trail, the majority (82.4%) had hiked on sections in North Carolina.

RQ 1. Does the timing of a low-impact hiking educational message influence individuals' compliance with low-impact hiking recommendations?

Among 47 participants, the average rate of compliance with the low-impact hiking recommendations was 64.7%. Specifically, compliance rates ranged from 40.4% (Trail condition 4) to 89.1% (Trail condition 5; Table 4.2). Group 2 had the highest average compliance rate (78.0%), followed by Group 1 (68.8%) and then the Control group (42.7%). The model fit the data (Deviance = 1531.51, df = 270). The differences among the three groups were significant (F-value = 5.82, p-value = 0.0033). On average, the logit of complying with low-impact hiking recommendations dropped from 1.8 for Group 2 to 1.0 for Group 1, and to -0.3 for the Control group. The corresponding probability of low-impact hiking behavior across trail conditions was 0.74 for Group 1, 0.86 for Group 2, and 0.42 for the Control group. The results suggested the overall effectiveness of the electronic educational message on participants' compliance with low impact hiking recommendations. After adding participants' hiking frequency, level of backcountry experience, Appalachian Trail hiking experience, and age as control variables to the mixed-effects logistic regression models (with both treatment groups and the control included), the treatment effect was still significant (F-value = 6.35, p-value = 0.0020). The model fit the data (Deviance = 1468.51, df = 269). Hiking frequency was the only significant control variable to predict compliance with low-impact hiking recommendations (F-value = 4.68, p-value = 0.0033). Individuals reporting they hiked more than 10 times per year were most likely to follow

low-impact hiking behavioral recommendations, while individuals who hiked 6 to 10 times a year were least likely to comply with low-impact hiking recommendations.

To determine the timing effects, we used another logistic regression with random effects and control variables for only the two experimental groups (i.e., Group 1 and Group 2). Those results revealed no significant differences in the willingness to comply between the two groups (F -value = 0.44, p -value = 0.5091). The model fit the data (Deviance = 1094.26, df = 193). The timing of our low-impact educational message did not influence individuals' compliance with low-impact hiking recommendations, after controlling for the effects of hiking frequency, level of backcountry experience, and age.

RQ 2. Does the timing of a low-impact hiking educational message influence individuals' knowledge levels and retention of the information delivered through that message?

Data from the post-survey indicated most participants were able to correctly recognize at least two of the three correct recommended low-impact hiking behaviors. About half (46.8%) of participants were able to recognize all three recommended low-impact hiking behaviors (Table 4.3). Over 95% of participants were able to recognize item 2, "if you encounter wood or stone steps, walk on them rather than around them", as recommended (Table 4.4). This was followed by item 1 "if there is a mud puddle in the middle of the trail, get muddy and walk right through it" with 74.5% of participants identifying it correctly as a recommended low-impact hiking behavior. Participants had more difficulty recognizing the third hiking behavior, "if the trail is not totally dry, choose the wet part to step on rather than walking on dry barren soil or grasses along the edges" (selection accuracy rate = 55.3%), as a recommended low-impact hiking behavior. Part of the differences among knowledge items could have been due to the fact the

third behavior was not directly addressed in the educational messages, whereas the first two hiking behaviors were.

Using a mixed-effects logistic regression model with participants and knowledge item as the random effects, the difference in the knowledge level measured in the post-survey among the three groups was significant ($F\text{-value} = 7.58$, $p\text{-value} = 0.0009$), with Group 2 having the highest probability of being able to correctly identify low-impact hiking behaviors (0.90), followed by Group 1 (0.89). The model fit the data ($\text{Deviance} = 745.13$, $df = 92$). The Control group had the lowest probability of being able to correctly identify low-impact hiking behaviors (0.53). The educational message increased participants' knowledge levels. Another mixed-effects logistic regression model was fit only for participants in the two experimental groups; the results revealed no significant difference between Group 1 and Group 2 ($F\text{-value} = 0.08$, $p\text{-value} = 0.7728$), suggesting the timing of the educational message did not influence knowledge retained. The model fit the data ($\text{Deviance} = 503.56$, $df = 66$).

Using a logistic regression model with repeated measures, we found no significant effects of message timing ($F\text{-value} = 0.08$, $p\text{-value} = 0.7906$; Table 4.5) or interaction between treatment and the timing of knowledge measurement ($F\text{-value} = 0.42$, $p\text{-value} = 0.5183$), suggesting knowledge was retained during the time interval between receiving the message and the experiment. The model fit the data ($\text{Deviance} = 997.62$, $df = 98$). It is worth noting that the pre-survey of knowledge was administered *after* individuals viewed the educational message. The comparison between pre- and post-survey knowledge levels was an indicator of knowledge retention but not knowledge change before and after the educational message.

RQ 3. Does the timing of a low-impact hiking educational message influence individuals' attitudes towards two low-impact hiking behaviors?

Two specific attitudes were examined including attitude toward walking through puddles, mud, or rugged spots on the trail, and attitude toward walking on wood or rock steps rather than around them. Specifically, after the experiment, most participants considered walking through puddles, mud, or rugged spots on the trails as good ($\bar{x} = 1.7$), wise ($\bar{x} = 1.2$), relatively easy ($\bar{x} = 0.9$), and necessary ($\bar{x} = 1.3$; Table 4.6). There were mixed responses in the post-survey about whether walking through puddles, mud, or rugged spots was convenient ($\bar{x} = 0.2$). Most participants considered walking through puddles, mud, or rugged spots to be unpleasant ($\bar{x} = -0.2$). Conversely, participants reported more positive attitudes toward the behavior of walking on wood or rock steps rather than around them (Table 4.7). The majority of all participants considered walking on steps good ($\bar{x} = 2.4$), wise ($\bar{x} = 2.2$), easy ($\bar{x} = 1.7$), necessary ($\bar{x} = 2.1$), pleasant ($\bar{x} = 1.9$) and convenient ($\bar{x} = 1.9$). The findings revealed different attitudes toward the two low-impact hiking behaviors.

Attitudes toward walking through puddles, mud, or rugged spots on trails.

A significant difference was observed across the attitude measures in the post-survey among three groups (Wilks' Lambda = 0.50, F-value = 2.69, p-value = 0.0044), suggesting an effect of the educational message on the overall attitudes toward walking through puddles, mud, or rugged spots on the trail. The follow-up univariate analyses (one-way ANOVA) for each attitude measure revealed that participants who received an educational message considered walking through puddles, mud, or rugged spots significantly better, wiser, more pleasant, and necessary relative to those participants who had not received the educational message (Table 4.8). No significant differences were found for the other two attitude measures using the easy-

hard and convenient-tiresome anchor-pairs. Post-hoc comparisons found most differences were between the Control group and each of the two treatment groups (Table 4.8). No significant differences were found between Groups 1 and 2, suggesting the timing of educational messaging did not influence participants' attitudes toward walking through puddles, mud or rugged spots on trails.

MANOVA with repeated measure revealed no difference between pre- and post-survey attitudes scores (Wilks' Lambda = 0.79, F-value = 1.20, p-value = 0.3341). Twelve paired t-tests were conducted to compare each pair of pre- and post-surveys attitude measures between the two treatment groups (Table 4.9). We did not find any significant differences, confirming the timing of educational messaging did not influence the stability of attitudes toward walking through puddles, mud, or rugged spots on trails. It is worth recalling that the pre-survey of attitudes was administered *after* individuals viewed the educational message. The comparison between pre- and post-survey attitudes scores was an indicator of retention but not attitudinal change before and after the educational message.

Attitudes toward walking on wood or stone steps.

Conversely, no significant differences were found across three groups in terms of participants' attitudes toward walking on steps rather than around them (Wilks' Lambda = 0.73, F-value = 1.09, p-value = 0.3835). Participants reported positive attitudes toward walking on steps in the post-survey, regardless of whether they received the educational message or not. Univariate analyses confirmed the results of no significant differences among groups for each attitude measure (Table 4.10). Post-hoc comparisons identified one significantly different pair between Group 1 and the Control group – participants in Group 1 considered walking on steps significantly wiser than those in the Control group. No differences were found between Group 1

and Group 2 on attitudes toward walking on steps rather than around them between pre-survey and post-survey (Wilks' Lambda = 0.72, F-value = 1.77, p-value = 0.1431; Table 4.11); this suggests that differences in the timing of educational messaging did not influence participants' attitudes towards walking on steps rather than around them.

Discussion

This study examined whether or not the timing of an educational message influences compliance with low-impact hiking recommendations as well as associated knowledge levels and attitudes. Our first purpose was to compare individuals' compliance with low-impact hiking recommendations when the timing of an educational message varied (i.e., at least 24 hours before or immediately before a simulated hiking trip). We found receiving an educational message increased participants' compliance with two specific low-impact hiking recommendations: 1) walking through puddles, mud, or rugged spots; and 2) walking on steps rather than around them. We observed a decrease in compliance when individuals watched the video and read the educational message more than 24 hours before (68.8%) compared to those individuals who received the educational message immediately before (78.0%) the simulated hiking trip; however, the magnitude of this decrease was not statistically significant.

A secondary purpose of this research was to compare knowledge levels and retention of information for educational messages delivered at various times prior to measurement. Viewing the educational video and statements increased participants' knowledge about low-impact hiking behaviors; we found a significant increase in knowledge scores from the Control group to the treatment groups. However, the two treatment groups were not significantly different in their knowledge levels, suggesting timing of the educational message did not influence knowledge level in this study. No significant difference was found between the pre-survey and post-survey

of knowledge levels either, regardless of the experimental group. The video and the short and straightforward statements may have been able to fully convey what the suggested hiking behaviors are. Moreover, the message focused on only two low-impact recreation behaviors, which may make it easier for participants to comprehend and memorize the contents of the message. The message of the video simply focused on which behaviors are suggested and which are not. It did not provide viewers extensive information about *why* these behaviors are suggested, which may actually keep viewers focused on the behavioral suggestions described in the video. The wording of the statements was pilot-tested for readability and whether individuals understood them in the way we expected them to. It seems that our simple message about desired behaviors was effectively conveyed to, and retained by, participants.

The third and final purpose of this research was to compare attitudes toward two specific low-impact hiking behaviors among participants and assess attitude stability between treatment groups. The educational video and message improved participants' attitudes toward walking through puddles, mud, or rugged spots on trails, but not their attitudes toward walking on wood or stone steps rather than around them. This difference might be attributable to individuals holding strong positive initial attitudes towards walking on steps rather than around them, suggested by the positive attitudes held by participants in the Control group. Our data did not include information about *why* individuals held positive initial attitudes toward walking on steps, but it is possible that individuals, particularly urban residents, are used to steps but not muddy trails. Thus, staying on steps seemed more familiar and positive to participants. Similar to knowledge, the timing of when participants received the educational message did not significantly influence their attitudes towards low-impact hiking behaviors. This may be because participants in Group 1 and 2 were not exposed to additional information or situations (e.g.,

hiking on a muddy trail) that could have changed their attitudes toward hiking through mud or on steps between the time they received the educational message and the time they came to the lab.

The results of this study are consistent with the stable-attitude hypothesis (i.e., attitudes will stay stable over a period of time after viewing/reading an educational message and continue to influence behaviors), but are not consistent with the forgetting-curve hypothesis (i.e., over a period of time, message recipients will forget the contents of educational message, their altered attitudes will not remain stable, and their behavior will gradually revert back to what it was before viewing/reading the educational material). We observed a positive behavioral intention change by comparing the two treatment groups with the Control group. Along with the behavioral change, our educational message was able to inform participants about low-impact hiking behavior and induce (or reinforce) participants' positive attitudes toward the two low-impact recreation behaviors. Their knowledge levels or attitudes did not decline over a relatively short time period. However, our study is not conclusive in terms of which hypothesis better explains the effects of timing of educational messaging on behaviors. The time interval of 24 to 72 hours may not be long enough for any long-term effects (i.e., forgetting the message's content, variations in attitudes toward the behavior) to be discernable. However, for natural areas that accommodate multi-day backcountry trips, 24 to 72 hours may still be the best window to reach visitors prior to their trips. The interesting question of how long the effect will last over a multiple-day or even multiple-week trip is worth examining.

The effectiveness of the electronic educational message on changing participants' behavioral intentions was encouraging. One reason for the positive effects could be that the message was able to influence participants' knowledge and attitudes, which stayed stable over time. However, we are not sure if we achieved a central-route to persuasion as described by the

Elaboration Likelihood Model (Roggenbuck 1992). We do not know how much thought participants put into the contents of the message, thought it was unlikely to be extensive considering student participants' typical daily mindset. Neither did our message give extensive arguments about why participants should hike through mud or on steps. In our study, individuals might not have had strong initial feelings regarding these behaviors, which probably contributed to the change of attitudes. This is supported by the near neutral or moderately positive attitudes held by participants in the Control group. Moreover, the experiment was conducted in an educational setting, possibly making participants more receptive to persuasive messages. The effectiveness of the message may also have been due to the attention participants paid to the message, particularly, the participants in Group 2 who viewed the message in a controlled laboratory environment. Although the experiment administrator did not watch participants closely as they viewed the message, the presence of the researcher may have led them to pay more attention to the message. Participants in Group 1 who viewed the message during their own time and preferred location may also have felt a need to pay carefully attention to the message since they knew they would be coming to the lab to do tasks related to the message.

Managerial Implications

This study supported the effectiveness of online visitor education programs. It is worth noting that creating and delivering an effective and well-designed online educational program is not an easy undertaking for recreation resource managers. Successful online educational programs require extensive planning, programming, and visual design, given they lack the benefits of personal contact and depend on visitors' willingness to engage with the material presented. Once the educational message is delivered, managers have less control compared to on-site educational programs. Recreation resource managers who are interested in developing

and deploying online educational programs should strive to make messages visually appealing and fun. Additionally, managers may need to allocate extra staff time to respond to comments generated by their online educational materials. Another consideration related to online educational programs is the potential burden they pose on visitors to take the time to engage in the educational program (similarly to the public time burden involved in participating in surveys). A well thought-out plan is needed if managers hope to implement communication strategies that include both online and on-site educational materials. Some relevant questions that need to be answered when developing such plans include: How much time does the manager expect visitors to devote to the education program? Should the online education become a requirement for certain types of recreation activities (e.g., backcountry hiking)? How should managers protect individuals' privacy in the process of communication? Should the public be able to directly reply to educational messages delivered via email? If they can, who should be responsible for responding and how could managers be prepared to manage this increased demand on their time and resources?

This study used an educational message integrating videos from the Appalachian Trail Conservancy and carefully crafted follow-up statements to influence participants' low-impact recreation behavior, knowledge, and attitudes. Our message focused on a small number of specific behaviors that have implications for visitor education program development. Commonly used low-impact recreation guidelines, such as Leave No Trace principles, are necessarily broad and applied in multiple contexts. Each principle could be expanded to include multiple recommendations and the "best" behavior could change dramatically based on the context (Marion 2014). Such breadth and complexity of low-impact recreation education. On one hand, an

educational message that only focuses on broad principles may compromise the depth of the materials and not be able to provide sufficient guidance for individuals to make environmentally responsible decisions. On the other hand, an educational message focused on specific behaviors may be more effective; previous studies have noted the importance of specificity in educational message and program development (Bissix et al., 2009; Brown, et al. 2010; Hughes, et al. 2009). This study demonstrated the benefits of a specific educational message, including a clear theme that facilitated understanding and retention.

Limitations and Future Research

In this study, we simulated a personal hiking situation and did not take social norms or group interactions into consideration. The effects of social norms and group and self-identity on behavior and attitudes change have been well documented in social-psychology (Bohner and Dickel 2011; D. T. Miller and Prentice 2016) and outdoor recreation studies (Cialdini et al. 2006; Widner and Roggenbuck 2000). Future research should assess group interactions in terms of complying with low-impact recreation recommendations by differentiating the type of educational messages recreationists receive. Second, despite our best efforts in recruiting participants, this study did not attain the desired sample size. Caution should be used when generalizing the results to larger populations. However, the sample compliance rates and estimated coefficients are still informative.

The third limitation is related to social desirability. It is a common concern that participants report intent to engage in desirable behavior, while they would not do so outside the context of a study. There have been mixed findings about how self-reported recreation behavior matches individuals' actual behavior (Jett, 2007; Park et al., 2008; Reigner & Lawson, 2009). Unable to observe participants' actual hiking behaviors under degraded trail conditions, we took

several steps to reduce the influence of social desirability. First, we told participants this study was not a test or an evaluation and that they were not being graded based on their responses. Most participants responded to this instruction by smiling or nodding, suggesting an understanding that the study was focused on their actual behavioral intentions. Second, once the lab task started, the researcher moved to the side of the display facing the opposite direction from the screen to avoid participants feeling watched while they indicated their intended hiking behaviors (Appendix H). Participants rarely talked during the drawing task, suggesting they felt no need to justify their choices to the researcher.

Compared to previous low-impact recreation research, this study employed substantial improvements in design for understanding recreationists' contingent hiking behaviors. First, behavioral intentions were measured through participants actually drawing their hiking routes on large format digital photographs rather than simply asking them to report whether they would hike in the center, on the edge, or off the trail. Participants did not need to have the same ability to distinguish trail centers, edges, or off-trail to report their intended hiking route. Their drawings were blind coded by a trail expert, which we believe increased the consistency and validity of our behavioral intention measures. Some participants commented that the experimental task was fun and easy. Additionally, the use of semantic differential scales for attitudes was an improvement over most past approaches that only focused on the cognitive component of attitudes. The six pairs of anchor words captured the affective components of attitudes and provided deeper understanding of the multi-faceted nature of attitudes toward low-impact hiking behaviors. Additionally, the experiment was administered by the same researcher for all participants which eliminated variance introduced by experiment administrators. The pilot test of

experimental procedures and scripts was found to be instrumental in refining the data collection protocols as well as measurement item development.

There are many opportunities to expand and advance this line of inquiry. With larger samples, studies could be expanded to include other psychological factors such as personal norms, environmental attitudes, and place attachment. The influence of the differential timing of educational messages could be more fully understood by examining longer time intervals. More importantly, other research questions could be posed beyond those used for our study. The first potential question is how the complexity of the message influences the retention of a behavioral change effort. Low-impact recreation education programs are diverse in how much information they provide to visitors (e.g., a sign versus an interpretive film). The complexity of a message may influence its effects through the mediating influence of attention (e.g., the more complex a message is, the less attention a recipient might give to it), and comprehension (e.g., the more complex a message is, the less likely a recipient may be able to comprehend it). Research on this question could help in designing well-balanced messages. Another question is whether a traditional educational context makes participants more receptive to educational messages. Changing participant populations from students to prospective hikers would be one way to address this question. Researchers could also consider recruiting student participants through avenues other than classrooms, such as student outdoor organizations or special events and using undergraduate recruiters to make participation feel less academically-oriented. It would also be useful to examine how attention influences individual receptivity to low-impact recreation educational messages. A larger sample of prospective hikers who view the message on their own may reveal individual differences in attention levels and whether they might respond to the messages differently. It is also important for future work to implement field-based studies to test

the effects of online educational programs such as the one we used in this study or the Leave No Trace online awareness programs on observed hiking behaviors.

Conclusions

We found an electronic educational message using video and written statements significantly improved participants' knowledge levels, attitudes toward, and intent to hike through muddy and wet trails and stay on steps rather than walk around them. A short time difference between the educational message and the behavior measurement (e.g., 24 to 72 hours) did not change the effects of the educational message on knowledge, attitudes, and behavioral intentions. It is our hope that this study and related ones in the future will assist natural resource managers and researchers in their efforts to provide high quality outdoor recreation opportunities while protecting the natural resources upon which those opportunities depend.

References

- Ajzen, I. (2001) Nature and operation of attitudes. *Annual Review of Psychology* 52:27–58.
- Bissix, G., Rive, K., & Kruisselbrink, D. (2009) Identifying key messages to encourage minimal impact on the cape split trail. *Leisure/Loisir* 33:615–636.
doi:10.1080/14927713.2009.9651455
- Bohner, G., & Dickel, N. (2011) Attitudes and Attitude Change. *Annual Review of Psychology* 62:391–417. doi:10.1146/annurev.psych.121208.131609
- Bradford, L., & McIntyre, N. (2005) Off the beaten track : messages as a means of reducing social trail use at St . Lawrence Islands National Park. In *2005 Parks Recreation Forum of Ontario*.
- Bromley, M., Marion, J. L., & Hall, T. (2013) Training to teach Leave No Trace : efficacy of Master Educator Courses. *Journal of Park and Recreation Administration* 31:62–78.
- Brown, T. J., Ham, S. H., & Hughes, M. (2010) Picking up litter: an application of theory-based communication to influence tourist behaviour in protected areas. *Journal of Sustainable Tourism* 18:879–900. doi:10.1080/09669581003721281
- Cialdini, R. B., Demaine, L. J., Sagarin, B. J., Barrett, D. W., Rhoads, K., & Winter, P. L. (2006) Managing social norms for persuasive impact. *Social Influence* 1:3–15.
doi:10.1080/15534510500181459
- Daniels, M., & Marion, J. L. (2005) Communicating leave no trace ethics and practices: efficacy of two-day trainer courses. *Journal of Park and Recreation Administration* 23:1–19.
- Doucette, J. E., & Cole, D. N. (1993). *Wilderness visitor education: Information about alternative techniques. Forest Service general technical report* (No. PB-93-159168/XAB; FSGTR/INT--295). Forest Service, Ogden, UT (United States). Intermountain Research

Station.

Eagly, A. H., & Chaiken, S. (1993a) Process theories of attitude formation and change: reception and cognitive responding. In *The Psychology of Attitudes* (pp. 257–297). Orlando, FL: Harcourt Brace & Company.

Eagly, A. H., & Chaiken, S. (1993b) Process theories of attitude formation and change: the elaboration likelihood and heuristic-systematic models. In *The Psychology of Attitudes* (pp. 305–349). Orlando, FL: Harcourt Brace & Company.

Eagly, A. H., & Chaiken, S. (1993c) The impact of attitudes on behaviors. In *The Psychology of Attitudes* (pp. 155–217). Orlando, FL: Harcourt Brace & Company.

Erdelyi, M. H. (2010) The ups and downs of memory. *American Psychologist* 65:623–633.

doi:10.1037/a0020440

Hayes, D. G. (2008) An investigation of behavior in recreation and tourism settings: a case study of natural hazard management at the Glaciers, Westland National Park, New Zealand. Lincoln University.

https://researcharchive.lincoln.ac.nz/bitstream/10182/1073/7/chittock_mps.pdf.txt.

Accessed 1 July 2015

Hughes, M., Ham, S. H., & Brown, T. (2009) Influencing park visitor behavior : a belief-based approach. *Journal of Park and Recreation Administration* 27:38–53.

Jacobi, C. (2003). An experiment using signs to reduce visitor-built cairns in Acadia National Park. *Acadia National Park Natural Resources Report*, 4.

Jett, J. S. (2007) Boater compliance behavior in manatee conservation zones: Recreation specialization, attitudes and situational factors. University of Florida. Retrieved from <http://search.proquest.com/docview/304869811?accountid=30037>. Accessed 1 July 2015

- Jones, M. K. (2004) Frontcountry Leave No Trace Program Evaluation. In *International Symposium on Society and Resource Management* (pp. 1–18). Keystone, Colorado.
- Lawhon, J. B. (2007). *Influencing Leave No Trace behavioral intentions in frontcountry visitors to national and state parks* (Doctoral dissertation, Colorado State University. Libraries).
- Manfredo, M. J., & Bright, A. D. (1991) A model for assessing the effects of communication on recreationists. *Journal of Leisure Research* 23:1. doi:10.1017/CBO9781107415324.004
- Manning, R. E. (2011) Managing outdoor recreation: alternative management practices. In *Studies in Outdoor Recreation: Search and Research for Satisfaction* (3rd Eds., pp. 273–321). Corvallis, OR: Oregon State University Press.
- Marion, J. L. (2014) *Leave No Trace in the Outdoors*. Mechanicsburg, PA: Stackpole Books.
- Marion, J. L., Leung, Y., Eagleston, H., & Burroughs, K. (2016) A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry* 114:1–17. doi:10.5849/jof.15-498
- Marion, J. L., & Reid, S. E. (2007) Minimising visitor impacts to protected areas: the efficacy of low-impact education programmes. *Journal of Sustainable Tourism* 15:5–27. doi:10.2167/jost593.0
- McGuire, W. J. (1968) Personality and attitude change: an information-processing theory. In A. G. Greenwald, T. C. Brock, & T. M. Ostrom (Eds.), *Psychological Foundations of Attitudes* (pp. 171–196). San Diego, CA: Academic Press.
- Miller, D. T., & Prentice, D. A. (2016). Changing norms to change behavior. *Annual Review of Psychology* 67:339–61. doi:10.1146/annurev-psych-010814-015013
- Miller, N., & Campbell, D. T. (1959) Recency and primacy in persuasion as a function of the timing of speeches and measurements. *Journal of Abnormal Psychology* 59:1–9. d

oi:10.1037/h0049330

Murre, J. M. J., & Dros, J. (2015) Replication and analysis of Ebbinghaus' forgetting curve.

PLoS ONE 10:1–23. doi:10.1371/journal.pone.0120644

National Parks Conservation Conservation (NCPA). (2009). *National Parks Second Century Commission: advancing the National Park idea.*

https://www.nps.gov/civic/resources/Commission_Report.pdf Accessed 1 July 2015

Park, L. O., Manning, R. E., Marion, J. L., Lawson, S. R., & Jacobi, C. (2008) Managing visitor impacts in parks: A multi-method study of the effectiveness of alternative management practices. *Journal of Park and Recreation Administration* 26:97–121.

Reigner, N., & Lawson, S. R. (2009) Improving the efficacy of visitor education in Haleakala National Park using the Theory of Planned Behavior. *Journal of Interpretation Research* 14:21–45.

Roggenbuck, J. W. (1992) Use of persuasion to reduce resource impacts and visitor conflicts. In M. J. Manfredo (Ed.), *Influencing Human Behavior: Theory and Application in Recreation, Tourism, and Natural Resource Management* (pp. 149–208). Champaign, IL: Sagamore Publishing.

Schulz, K. F., & Grimes, D. A. (2002) Blinding in randomised trials: Hiding who got what. *Lancet* 359:696–700. doi:10.1016/S0140-6736(02)07816-9

Siderelis, C., Moore, R. L., Leung, Y. F., & Smith, J. W. (2012). A nationwide production analysis of state park attendance in the United States. *Journal of Environmental Management* 99:18–26. doi:10.1016/j.jenvman.2012.01.005

U.S. Department of Health and Human Services Food and Drug Administration (1998) Guidance for industry E9 statistical principles for clinical trials.

<http://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm073137.pdf> Accessed 1 July 2015

Vagias, W. M., Powell, R. B., Moore, D. D., & Wright, B. A. (2014) Predicting behavioral intentions to comply with recommended leave no trace practices. *Leisure Sciences* 36:439-457. doi:10.1080/01490400.2014.912168

Watts, W. A., & McGuire, W. J. (1964) Persistence of induced opinion change and retention of the inducing message contents. *Journal of Abnormal Psychology* 68:233–241. doi:10.1037/h0041081

Widner, C. J., & Roggenbuck, J. W. (2000) Reducing theft of petrified wood at Petrified Forest National Park. *Journal of Interpretation Research* 5:1–18.

Table 4. 1. Participants' profile.

		Frequency	%
<i>Gender</i>			
	Female	29	61.7
	Male	18	38.3
<i>Race</i> ^a			
	American Indian or Alaskan Native	1	2.1
	Asian American	1	2.1
	Black or African American	1	2.1
	Native Hawaiian or other Pacific Islander	0	0
	White	44	93.6
	Other ^b	3	6.3
<i>Age</i> ^c			
	Under 20	5	10.6
	20-24	38	80.8
	25-30	1	2.1
	Over 30	2	4.3
<i>College major</i>			
	PRTM-Program Management	16	34.0
	PRTM-Park and Natural Resource	8	17.0
	Professional Golf Management	5	10.6
	PRTM-Tourism and Commercial Management	4	8.5
	Other ^d	5	10.6
	Biology, environmental science	4	8.5
	Undecided	3	6.4
	Business	2	4.3
<i>Hiking frequency</i>			
	Never	2	4.3
	1-5 times a year	24	51.1
	6-10 times a year	6	12.8
	More than 10 times a year	15	31.9
<i>Previous A.T. experience</i>			
	Yes-hiked on the A.T. before	17	36.2
	No	27	57.4
	Not sure	3	6.4

^a Some participants identified themselves with multiple racial groups.

^b "Other" for race included Greek, Middle Eastern, Human, and American Indian/White/Mexican.

^c One participant did not report his or her age.

^d "Other" for college major included Animal Science (n = 2), Communication/Public Relations (n = 1), and Nutrition (n = 1). One participant did not specify the major.

Table 4.2. Compliance rates with low-impact hiking recommendations by group and photos.

	Overall	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7
All	64.7	75.6	63.0	56.5	40.4	89.1	53.2	76.1
Group1	68.8	82.4	55.6	66.7	33.3	88.9	66.7	88.9
Group2	78.0	81.3	80.0	75.0	68.8	93.3	68.8	80.0
Control	42.7	58.3	53.8	16.7	15.4	84.6	15.4	53.8

Note. TC: trail condition. Trail conditions 1 through 4 are muddy and wet trails. Trail conditions 5 and 6 are trails with steps.

Table 4.3. Percentage of individuals who correctly identified three, two, or one knowledge item from post-survey data.

Number of Correctly Identified Items			
	Three	Two	One
Overall	46.8	31.9	21.3
Group1	61.1	27.8	11.1
Group2	56.2	43.8	0.0
Control	15.4	23.1	61.5

Table 4.4. Participants' selection accuracy rates from post-survey by group and knowledge items from post-survey data.

	Overall	Item 1	Item 2	Item 3
Overall	75.2	74.5	95.7	55.3
Group1	83.3	83.3	94.4	72.2
Group2	85.4	100.0	93.8	62.5
Control	51.3	30.8	100.0	23.1

Note. The selection accuracy rate is calculated as the total proportion of knowledge items correctly identified as low-impact hiking behaviors from the total number of knowledge items presented.

Table 4.5. Participants' selection accuracy rates by experimental groups and pre-/post-surveys.

	Pre-survey	Post-survey
Group 1	81.5	83.3
Group 2	77.1	85.4

Note. The selection accuracy rate is calculated as the total proportion of knowledge items correctly identified as low-impact recreation behavior from the total number of knowledge items presented.

Table 4.6. Descriptive statistics of attitudes toward walking through any puddles, mud, or rugged spots on the trail, rather than walking around them from post-survey data.

	Frequency							Mean	SD	Median	
	3	2	1	0	-1	-2	-3				
Good	11	12	6	7	7	4	0	Bad	1.0	1.7	1
Wise	18	7	6	4	5	7	0	Foolish	1.2	1.9	2
Pleasant	4	6	5	8	11	11	2	Unpleasant	-0.2	1.7	-1
Easy	9	10	9	10	5	3	1	Hard	0.9	1.6	1
Convenient	4	7	11	7	10	6	2	Tiresome	0.2	1.7	0
Necessary	18	8	9	3	3	3	3	Not necessary	1.3	1.9	2

Table 4.7. Descriptive statistics of attitudes toward walking on wood or rock steps rather than around them from post-survey data.

	Frequency							Mean	SD	Median	
	3	2	1	0	-1	-2	-3				
Good	30	10	5	1	0	0	1	Bad	2.4	1.1	3
Wise	29	7	7	3	0	0	1	Foolish	2.2	1.2	3
Pleasant	22	12	5	4	3	1	0	Unpleasant	1.9	1.4	2
Easy	17	14	5	7	2	2	0	Hard	1.7	1.4	2
Convenient	20	15	3	6	3	0	0	Tiresome	1.9	1.3	2
Necessary	27	10	4	4	1	0	1	Not necessary	2.1	1.3	3

Table 4.8. Comparisons of attitudes toward walking through any puddles, mud, or rugged spots on the trail, rather than walking around them among three groups from post-survey data.

		Group 1	Group 2	Control	F-value	<i>p</i> -value
		Mean	Mean	Mean		
Good	- Bad	1.4 ^a	1.6 ^b	-0.2 ^{ab}	6.41	0.0036
Wise	- Foolish	2.1 ^a	1.4 ^b	-0.3 ^{ab}	7.82	0.0012
Pleasant	- Unpleasant	-0.2	0.5 ^a	-1.2 ^a	3.73	0.0320
Easy	- Hard	1.1	1.1	0.3	1.21	0.3082
Convenient	- Tiresome	-0.1	0.8	-0.2	1.82	0.1735
Necessary	- Not necessary	1.8 ^a	2.1 ^b	-0.4 ^{ab}	9.86	0.0003

Note. Means with same letter superscripts are significantly different at the 0.05 level.

Table 4.9. Means of attitudes toward walking through any puddles, mud or rugged spots on the trail, rather than walking around them by pre-/post surveys and experimental groups.

		Group 1			Group 2		
		Pre	Post	t-value	Pre	Post	t-value
Good	- Bad	1.1	1.4	-1.14	1.9	1.6	0.56
Wise	- Foolish	1.7	2.1	-1.69	1.9	1.4	1.65
Pleasant	- Unpleasant	-0.4	-0.2	-1.23	0.1	0.5	-1.69
Easy	- Hard	0.6	1.1	-1.49	1.0	1.1	-0.32
Convenient	- Tiresome	0.2	-0.1	0.74	0.8	0.8	0.00
Necessary	- Not necessary	1.6	1.8	-0.55	2.1	2.1	0.29

Note. Pre-survey (Pre) attitudes were measured *after* the educational message. Post-survey (Post) attitudes were measured *after* the experiment.

Table 4.10. Comparison of attitudes toward walking on wood or rock steps rather than around them among the two treatment groups and the Control group from post-survey data.

		Group 1	Group 2	Control	F-value	<i>p</i> -value
		Mean	Mean	Mean		
Good	- Bad	2.6	2.5	1.9	1.62	0.2104
Wise	- Foolish	2.7 ^a	2.3	1.6 ^a	2.96	0.0623
Pleasant	- Unpleasant	1.9	2.0	1.8	0.11	0.9004
Easy	- Hard	1.8	1.6	1.6	0.10	0.9051
Convenient	- Tiresome	1.8	2.2	1.8	0.55	0.5797
Necessary	- Not necessary	2.5	2.3	1.5	2.19	0.1244

Note. Means with same letter superscripts are significantly different at the 0.05 level.

Table 4.11. Means of attitudes toward walking on wood or rock steps rather than around them by pre-/post surveys and experimental groups.

		Group 1			Group 2		
		Pre	Post	t-value	Pre	Post	t-value
Good	- Bad	2.4	2.6	-1.00	2.6	2.5	0.29
Wise	- Foolish	2.7	2.7	0.00	1.9	2.3	-1.86
Pleasant	- Unpleasant	1.8	1.9	-0.68	2.1	2.0	0.52
Easy	- Hard	2.0	1.8	0.85	1.9	1.6	0.79
Convenient	- Tiresome	1.9	1.8	0.40	1.4	2.2	-2.55
Necessary	- Not necessary	2.3	2.5	-0.94	1.9	2.3	-.1.58

Please watch the video below and read the information about low impact hiking behavior on the Appalachian Trail that follows just after the video. After that, please answer the five questions at the end of this survey.



It is important to always stay in the middle of the trail while you are hiking in heavily used areas like much of the Appalachian Trail. Remember to:

- Walk through any puddles, mud, or rugged spots on the trail, rather than walk around them. This reduces trail widening and erosion.
- Walk on wood or stone steps rather than around them.
- Avoid walking on the edge of a trail or detouring around obstacles such as fallen branches to reduce trail widening.

Figure 4.1. Screen-shot of the educational message including the video and summary statements.



Figure 4.2. Trail photos used in this study. From top left to bottom right are trail conditions 1 through 7. Trail conditions 1 through 4 depicted muddy and wet trails. Trail conditions 5 through 7 depicted steep rails with steps.

CHAPTER 5: CONCLUSION

In this dissertation, I examined the behavioral phenomenon of low-impact recreation behavior through three separate but related studies. The first study, an integrated literature review, reviewed the diversity of theories and social-psychological constructs that have been used to study compliance with low-impact recreation behavioral recommendations. This review allowed me to identify several opportunities to advance recreation research through the use of a context-dependent and temporal-dynamic approach. The second study, a survey of long-distance hikers' compliance with low-impact recreation behavioral recommendations, examined an often omitted factor in low-impact recreation research – values. Results from this study improved our theoretically- and empirically-grounded understanding of exactly which values are most strongly correlated with low-impact recreation behavior. The final study, a lab-based experiment, tested the effects of timing of educational messaging on compliance with low-impact recreation behavioral recommendations. The relatively strict controls offered by the lab setting provided an ideal venue to test whether educational messaging has the ability to influence compliance with low-impact recreation behavioral recommendations after the message is received by recreationists; the data suggest it can. This final chapter attempts to integrate the findings from the three studies to explain why individuals comply with low impact recreation behavioral recommendations or not and how to influence individual recreation behaviors. Implications for future research and management are also discussed.

Reasons for Compliance and Non-Compliance

A large body of low-impact recreation research has focused on how social-psychological constructs determine individuals' compliance with low-impact recreation behavioral recommendations. Often, these studies assume that how individuals think and feel influences how they will act. Through the integrated literature review, I identified 55 social-psychological constructs that have been used as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations such

as attitudes toward specific behaviors, subjective norms, knowledge, environmental worldview and recreation specialization. The construct of attitudes toward specific behaviors was studied most often. The findings from the survey and experimental studies supported the important influence of attitudes toward specific behaviors on actual behavioral compliance with low-impact recreation behavioral recommendations. In the survey study, attitudes toward four low-impact recreation recommendations (i.e., “dig a ‘cathole’ to dispose of your human waste when a privie/outhouse was unavailable”, “camp on previously used campsites when you camp”, “use a bear canister to store your food and other smellable items”; and “hang your food and other smellable items”) were better predictors of the behavioral measures than other constructs including values, and attitudes toward an object/concept. In four predictive models (values → attitudes toward the behavior → compliance with low impact recreation recommendations), the coefficients of attitudes toward specific behaviors were larger than 0.3. In the experimental study, a significant change in attitudes toward walking through puddles, mud, and rugged spots on trails, accompanied the changes in the measures of behavior. Although the results do not demonstrate causal effects of specific attitudes on behavioral compliance, they suggest a close relationship between attitudes toward a specific behavior and the actual behavior compared to other social-psychological factors tested in this dissertation (i.e., values, attitude toward an object and attitudes toward a concept).

Given the strong, and consistent influence of attitudes on behavioral compliance, do values matter? The results from the survey study suggest that, yes they do matter, to some degree. Recreationists' values did directly influence attitudes toward specific behaviors, not through the mediation of other attitudinal factors. The results did not support the chain effect model of values → specific attitudes toward an object → attitudes toward a concept → attitudes toward specific behaviors. However, the effects of values on attitudes towards specific behavior was not strong or consistent across all of four recreation recommendations. In the values → attitudes toward specific behavior → actual behavior models, the coefficients of values types in predicting attitudes were lower than 0.3. The analyses also revealed a weak but inconsistent relationship between values and compliance with low-impact

behavioral recommendations. This contradicts my assumption that values is the prime social-psychological factor accounting for individual differences in their compliance with low impact recreation behavioral recommendations. Not finding a strong direct relationship between values and compliance with low-impact recreation behavioral recommendations could relate to the particular sample I used. For example, Appalachian Trail long distance hikers may have unique characteristics. Additionally, only half of the individuals in the sampling frame responded to the survey. It may also relate to the use of self-reported behavior measures. However, more importantly, it suggests there is danger in attributing non-compliance with low-impact recreation behavioral recommendations solely to recreationists' values.

Behavioral Change Interventions

The integrated literature review of the first study revealed general effectiveness of educational interventions in influencing compliance with low-impact recreation behavioral recommendations. The experimental study found a short delay (between 24 and 72 hours) between the educational message and behavioral compliance measurement did not reduce the effectiveness of the message. These finding are encouraging. However, they should be further tested with data describing recreationists' actual hiking behaviors (as opposed to their intended behaviors).

What is of more interests is the difference between practice-based and theory-based behavioral change interventions and the opportunities to integrate the two approaches. In the integrated literature review I coded behavior change interventions as either theory-based (i.e., those that explicitly reported how theories were used to develop the interventions) or practice-based, and found practice-based interventions were able to promote compliance with low-impact recreation behavior more often than theory-based interventions. As a response, I developed the educational message used in the lab-based study by utilizing existing educational materials and theories to optimize the effectiveness of the educational materials from a temporally-dynamic perspective. Specifically, I conceptualized the responses of social-psychological constructs to persuasive messages using the information processing paradigm. Before designing the intervention, I deliberated its interactions with key social-psychological mechanisms

(e.g., attention, comprehension, and agreement) at every step of the process for individuals receiving the educational message and attempted to make the message resonate with participants' attitudes and knowledge towards compliance (the critical social-psychological factors which literature suggests are important for developing effective educational messaging). This approach demonstrates that practice- and theory-based interventions can be integrated using a temporal-dynamic framework.

Theory-based Research Approach

In this dissertation, I applied two approaches to conduct theory-based empirical studies. The second study tested theory-grounded prediction models explaining the compliance with low impact recreation recommendations using values and attitudinal factors. The third study examined effects of behavioral change interventions on behavior and social-psychological factors. The integrated review documented in the first paper described the *prediction model studies* as using a two-phrase study approach. The two phrases are the social-psychological factors leading to actual behavior. The *behavioral change studies* used a three-phrase study approach. To employ this approach, researchers introduce an intervention between social-psychological factors and behaviors resulting in three phrases (initial social-psychological factors → post-intervention social-psychological factors → behavior). Through using both approaches, I was able to generate informative results in this dissertation.

However, it is worth noting that there are some limitations specific to the two-phrase approach when it comes to predicting complex low-impact recreation behavior. The first study found that for majority of studies using two-phrase approach, the proportions of variances explained by the social-psychological models fell in the range of 15.0% to 37.95%. The value→attitudes→behavior models fitted with the second study explained 10.9% to 26.4% of the variance in the measures of compliance with low impact recreation behavioral recommendation. Based on the goodness-of-fit indices, the value→attitudes → behavior models fit the observed data acceptably, but were far from fully representing the data. Adding more social-psychological factors such as place attachment and recreation specialization might have improved the performance of the prediction model. Even so, the results about what values

influence behaviors and attitudes and in which ways may still not turn out as expected, pointing to another limitation of the two-phrase approach. In the second study, value types inconsistently correlated with compliance with low impact recreation behavioral recommendations. Some of the results even contradicted the hypotheses. For example, the value type of *Hedonism* positively correlated with the attitudes toward compliance with low impact recreation behavioral recommendations. The hypotheses were grounded on well-tested theories and other empirical studies. The study design, including questionnaire development and survey implementation, used common practices in survey studies such as using well-established measurement scales and Dillman's multiple contact survey technique. Still, more data are needed to explain why the results of the second study were surprising. It does suggest that single two-phrase model studies may be good at confirming theoretical hypotheses, but lack the ability to explain contradicting findings. With limited resources to conduct research, these limitations of the two-phrase approach are worth serious consideration when selecting research approaches to examine low impact recreation behavior.

In addition to carefully selecting research approaches, outdoor recreation researchers should constantly consider and refine the ethical grounding of low impact recreation research. Should science be used to *change* individuals' behaviors? What is the difference between manipulating and influencing another human being? Do we need stronger oversight to assure ethical approaches that are used in influencing individual behaviors? An important goal of low-impact recreation behavior research is to find more effective and efficient ways to influencing individual behaviors. However, there is a fine line between influencing people to behave appropriately while providing them with the unique freedom many people seek in outdoor recreation (Moore & Driver, 2005). Changing behaviors should not be the sole or even the ultimate goal for low impact recreation research. The research community is often established in well-accepted social norms. However, for individual researchers, a constant check of research ethics is as relevant as the quality of the research for the line of research on low-impact recreation behavior. It is important for social scientists to improve the ability of individuals to have high-quality recreation

experiences through a better understanding of how values, attitudes and educational messaging can be used to promote more environmentally-responsible recreation behavior.

Managerial Implications

Through the integrated literature review documented in the first study, I identified a variety of ways in which researchers have framed the concept of low-impact recreation behaviors, such as responsible recreation behavior, ecological recreation behavior, Leave No Trace behavior and compliant behavior, in contrast to vandalism and deprecative recreation behavior. These phrases reflect various views of visitor behavior and visitor use management. The terms or phrases such as vandalism, deprecative recreation behavior and responsible recreation behavior indicate some visitor behaviors are *good*, while others are *bad*. Such judgments are sometimes based on inferences of individual intentions. Are they behave responsibly when they recreate? Do they appreciate the natural resources? There is often a sense of moral standards applied to how individuals recreate. On the other hand, the phrase of low impact recreation behavior focuses on the consequences behind how individuals recreate. Often experts or natural resource managers identify the need for behavioral change based on relevant research and/or a “behind-the-scene” understanding of issues facing the recreation settings.

The various views of visitor behavior and visitor use have implications for natural resource management. It is important for natural resource managers to consider the power dynamic in deciding which behaviors at recreation settings are acceptable. Public agencies certainly have authority and expertise in terms of natural resource protection. However, an expectation of visitors simply deferring to the authority is not feasible or ethical in a democratic society. In reality, visitors can choose to accept or not accept the agencies’ authority and expertise. Trust plays an important role in the success of visitor education and visitor use management. To building trust and support among the managers’ constituents, cautions should be used to avoid the mindset of “we know better than the recreationists”. Collaborate relationship is vital in preventing conflict.

Moreover, visitors to natural areas should be considered as collaborators in protecting natural resources, rather than the problem. Most visitors to natural areas do value natural resources (Knopf & Andereck, 2004; Vande Kamp, Johnson, & Sewaringen, 1994). For example, my second study found caring for the nature was valued the most strongly among Appalachian Trail long distance hikers, followed by learning things and improving abilities, and making own decisions. An impact-oriented view of the visitor behavior may be more constructive in visitor-manager relationship than an intention-oriented view. Focusing on the impact of visitor behaviors is not denying that some individuals hold views and priorities drastically in opposition to natural resource conservation. However, it sets a tone of collaboration between natural resource managers and visitors which would influence how natural resource managers interact with visitors. The partnership and collaborative traditions between public and natural resource management agencies have been powerful forces for the conservation of U.S. public lands and water for over a century. It has the potential to improving resources and recreation experiences and help managers with their dual mandate of protecting resources and provide recreation opportunities.

References

- Knopf, R. C., & Andereck, K. L. (2004). Managing depreciative behavior in natural settings. In M. J. Manfredo, J. J. Vaske, B. L. Bruyere, D. R. Field, & P. J. Brown (Eds.), *Society and natural resources: a summary of knowledge prepared for the 10th International Symposium on Society and Resource Management*. Jefferson, MO: Modern Litho.
- Moore, R. L., & Driver, B. L. (2005). Influencing and managing visitor behavior. In *Introduction to outdoor recreation* (pp. 233–247). State College, PA.
- Vande Kamp, M. E., Johnson, D. R., & Sewaringen, T. C. (1994). *Deterring minor acts of noncompliance a literature review*. Seattle,

APPENDICES

Appendix A Summary of Social-Psychological Factors Studied in less than Two Prediction Model Study for Chapter Two

Table A1. Socio-psychological factors conceptualized as predictors of compliance/non-compliance with low-impact recreation behavioral recommendations in less than two studies.

Factors Examined	Previous Research	Number of Articles	Number of Models	As Direct Effect S	N.S.	As Indirect Effect S	N.S.
Marine conservation attitudes	Jett 2007	1	1		1		
Perceived effectiveness	Lawhon 2013	1	12	10	2		
Past behavior	Serenari et al. 2012	1	3		3		
Cognition of cultural landscape experience	Zhang et al. 2015	1	6	6			
Emotion of environmental conservation	Zhang et al. 2015	1	6	5	1		
Cognition of natural landscape experience	Zhang et al. 2015	1	6	5	1		
Concerns about the behavior	Kim 2012	1	2	2			
Perception of ecosystem health	Alessa et al. 2003	1	1	1			
Consumptive orientation	Oh and Ditton 2008	1	1			1	
Biospheric-altruistic values	Van Riper and Kyle 2014	1	1			1	
Biospheric values	Lee and Jan 2015	1	3	3			
Egoistic values	Van Riper and Kyle 2014	1	1			1	
Environmental sensitivity	Cheng and Wu 2015	1	1	1		1	
Place affect	Ramikissoon et al. 2013	1	2	2			
Social bonding	Ramikissoon et al. 2013	1	2	2			
Affective destination image	Chiu et al. 2014	1	1	1			
Cognitive destination image	Chiu et al. 2014	1	1		1	1	
Perceived value	Chiu et al. 2014	1	1	1			
Specialization behavioral index	Thapa, et al. 2006	1	4	2	2		

Table A1. (continued.)

Specialization: affect index	Thapa, et al. 2006	1	4	3	1
Specialization: recreation index	Thapa, et al. 2006	1	4	3	1
Recreation experience	Lee and Jan 2015	1	3		3
Recreation experience: education	Lee et al. 2015	1	1	1	
Recreation experience: experiential engagement	Lee et al. 2015	1	1		1
Recreation experience: esthetics	Lee et al. 2015	1	1	1	
Recreation experience: escapism	Lee et al. 2015	1	1	1	
Self-reported compliance	Jett 2007	1	2	2	
Willingness to pay for conservation	Oh and Ditton 2008	1	1		
Activity-general preference	Oh and Ditton 2008	1	1		1
Activity-specific preference	Oh and Ditton 2008	1	1		1
Acquire new beliefs	Manfredo and Bright 1991	1	1	1	
Change prior beliefs	Manfredo and Bright 1991	1	1	1	
Thought generated	Manfredo and Bright 1991	1	1		1
Source credibility	Manfredo and Bright 1991	1	1		1
Prior knowledge	Manfredo and Bright 1991	1	1		1
Status in social group	Manfredo and Bright 1991	1	1		1
Need for cognition	Manfredo and Bright 1991	1	1		1
Direct experience	Manfredo and Bright 1991	1	1		1
Topic involvement	Manfredo and Bright 1991	1	1		1

Appendix B Survey Instrument One for Chapter Three

This instrument is for participants who voluntarily registered their completed hike through Appalachian Trail Conservancy in 2014 and 2015.

Cover Letter**NC STATE UNIVERSITY**

2016 Appalachian Trail Long Distance Hiker Survey

Hello 2000-Miler,

Congratulations again on completing the A.T. and thank you for agreeing to participate in this study about A.T. long distance hikers' experiences and attitudes. The purpose of this study is to gain a better understanding of what A.T. long distance hikers, including you, experienced on the trail. The results of this study will help resource managers from the Appalachian Trail Conservancy (ATC), their agency partners, and the 31 A.T. maintaining clubs develop strategies to more effectively care for the A.T. and support future visitors.

We value your opinions and your privacy. All your responses are anonymous and confidential and results will only be reported as summaries, without any identifying information. Your email address will not be shared with anyone and we will delete it upon completion of our study. Your participation in this study is completely voluntary. Although your responses are very important to us, you may choose to withdraw at any time or not answer particular questions.

If you have any questions or comments about this study, please contact us at tguo@ncsu.edu or (919)515-3698.

Sincerely,



Tian Guo, Ph.D. Candidate



Roger L. Moore, Ph.D.
North Carolina State University

Section 1 Information about Most Recent Thru- or Section Hike of the A.T.

Section 1 Your Most Recent Thru- or Section Hike of the Appalachian Trail (A.T.)

First, we would like to learn a bit about your most recent thru-or section hike of the A.T.

In what year was your most recent completion of the entire 2,190 miles of the A.T.?

2014

2015

Other (Please specify)

Did you complete the entire A.T. that time by:

Thru-hiking

Section hiking

In which direction did you thru-hike the A.T.?

Northbound

Southbound

Flip-flop

Other (Please specify)

What year did you hike the first section of this section hike?

Did you sign the A.T. register at the visitor center at Amicalola Falls State Park in Georgia?

Yes

No

Did you sign the A.T. register at the top of Springer Mountain?

Yes

No

What was your level of backcountry experience **before** your most recent A.T. thru- or section hiking trip?

Novice Expert

Section 2 Attitudes toward the A.T.

Section 2 Attitudes toward the Appalachian Trail (A.T.)

Now, we would like to know how you feel about the A.T. in general .

In general, my attitude toward the A.T. is:

Favorable Unfavorable

Please indicate how you feel about the A.T. by checking one response for each of the following pairs of descriptions.

The A.T. is...

Natural	<input type="radio"/>	Artificial
Unique	<input type="radio"/>	Common
Wilderness-like	<input type="radio"/>	Urban-like
Quiet	<input type="radio"/>	Noisy
Safe from crime	<input type="radio"/>	Unsafe from crime
Scenic	<input type="radio"/>	Unattractive

On a scale of 1 to 10, with 1 being **completely dissatisfied** and 10 being **completely satisfied**, how satisfied were you with your most recent A.T. thru- or section hiking trip?



Section 3 Recreation Behaviors and Attitudes

Section 3 Recreation Behaviors and Attitudes

Now, we would like to know a little more about what you did during your most recent A.T. thru- or section hiking trip. Remember, all your answers are anonymous and confidential. **Please think about your time on the A.T. during**

your most recent thru- or section hiking trip when responding to each question.

On that trip, how many nights did you spend **in the backcountry** (i.e., staying at shelters or camping)?

On that trip, how many nights did you spend **off the A.T.** (e.g., in nearby towns)?

On that trip, how frequently did you **carry out all of your own litter?**

Always

Most of the Time

Sometimes

Rarely

Never

On that trip, how frequently did you **carry out all the litter you found even if others left it before you?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **wash yourself and dishes at least 200 feet away from all streams and the other bodies of water?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **collect any rocks, plants or other natural items to keep?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **collect any cultural artifacts to keep?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **write your name on, draw on, or carve on any trees, shelters or other natural or man-made surfaces?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **build a campfire?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **construct a new fire ring?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **remove limbs from a live or dead tree to use as firewood?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **scatter your campfire ashes prior to leaving your campsite?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **short-cut switchbacks**?

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **camp on previously used campsites when you camped**?

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **use a bear canister to store your food and other smellable items**?

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **hang your food and other smellable items?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **dig a "cathole" to dispose of your human waste when a privie/outhouse was unavailable?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

How deep did you usually dig your cathole (in inches)?

What tools did you use to dig your catholes? (Please select all that apply)

Trowel

Boot

Sticks

Trekking poles

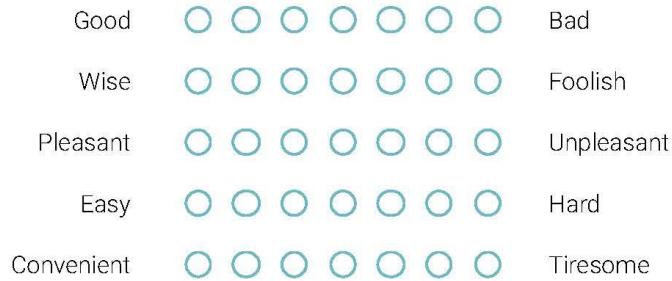
Other (Please specify)

Please indicate how you feel about the following behaviors on the A.T. by checking one response for each of the following questions:

Using catholes when privies/outhouses are not available is...

Camping only on previously used campsites is...

Using a bear canister to store your food and other smellable items is...

Hanging your food and other smellable items is...**Section 4 Attitudes toward Leave No Trace Principles****Section 4 Attitudes toward Leave No Trace Principles**

We are also interested in how you feel about the seven Leave No Trace principles. They are:

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

How would you rate your knowledge of Leave No Trace outdoor skills and practices?

I've never heard of them before this survey

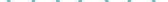
Novice

Intermediate

Advanced

Expert

In general, what is your attitude toward following the Leave No Trace principles when hiking on the A.T. ?

Favorable  Unfavorable

Please indicate how you feel about following the Leave No Trace principles when hiking on the A.T.:

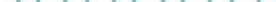
Following the Leave No Trace principles while on the A.T. is...

Good Bad

Wise Foolish

Pleasant Unpleasant

Easy Hard

Convenient  Tiresome

To what degree did you feel personally obligated to follow the Leave No Trace principles when you were on the A.T.?

- Not obligated at all
- A little obligated
- Somewhat obligated
- Very obligated
- Completely obligated

To what degree did you feel that following the Leave No Trace principles detracted from your enjoyment during your most recent A.T. thru- or section hiking trip?

- It didn't detract at all
- It detracted a little bit
- It was somewhat detracting
- It was very detracting
- Completely detracting

Which of the following education programs had you participated **in prior** to your most recent A.T. thru- or section hiking trip? (Please select all that apply)

- Leave No Trace Awareness workshop
- Leave No Trace on-line awareness course
- Leave No Trace Trainer Course
- Leave No Trace Master Educator Course
- Project WILD Program
- National Outdoor Leadership School (NOLS) course
- Outward Bound Course

Other (Please list)

None of the above

Did you see any Leave No Trace informational materials during your most recent A.T. thru- or section hiking trip? (Please select all that apply)

- No
- Yes, I saw trailhead signage
- Yes, I saw signs/posters in shelters
- Yes, on the hang tag I received when I registered my thru-hike
- Yes I saw Leave No Trace materials in other locations (Please describe)

Do you have any more comments you want to add about Leave No Trace principles on the A.T.?

Section 5 Values**Section 5 Values**

Now, we would like to know a little more about how you value various things in your life. Below are 57 portraits of a person's goals, aspirations, or wishes. Please indicate how much like you is the person.

To begin, please help us personalize the description wording for you. We simply want to be able to match the pronoun in each portrait to your preference.

What is the gender you identified with?

Male

Female

If you prefer, we can specify your gender descriptor as any other you might prefer (Please

specify)

Prefer not to disclose

These page timer metrics will not be displayed to the recipient.

First Click: 0 seconds

Last Click: 0 seconds

Page Submit: 0 seconds

Click Count: 0 clicks

How much like you is this person?

	Definitely not me	Not like me	Hard to say	Somewhat like me	Totally me
Being very successful is important to him	<input type="radio"/>				
He wants people to admire his achievement.	<input type="radio"/>				
He avoids anything that might endanger his safety	<input type="radio"/>				
His personal security is extremely important to him	<input type="radio"/>				
It is important to him to live in secure surroundings	<input type="radio"/>				
It is important to him that his country protects itself against all threats	<input type="radio"/>				
He wants the state to be strong so it can defend its citizens	<input type="radio"/>				
Having order and stability in society	<input type="radio"/>				

Note. The rest 39 value items could be found in Chapter 3 Table 3 Descriptive of respondents values

Section 6 Voluntary Thru-Hiker Registration System

Section 6 A.T. Thru-hiker Registration System

For the 2015 season, the Appalachian Trail Conservancy (ATC) developed (and is now refining) an on-line Voluntary Thru-hiker Registration System to help prospective long distance A.T. hikers share their itineraries with other overnight hikers and plan their itineraries in order to avoid the social and ecological impacts of overcrowding. We'd like to get your input on the Thru-hiker Registration System.

Did you register your planned thru-hike start date on the Thru-hiker Registration System?

Yes

No

Where did you first learn about the Thru-hiker Registration System?

On the ATC website

From social media (e.g., Facebook pages, twitter)

From guide books

From other thru-hikers

Other (Please list)

What was your chief motivation for using the Thru-hiker Registration System?
(Please select all that apply)

I was concerned about possible crowding along the A.T.

A friend recommended it.

I followed the suggestion on the ATC website.

I thought it was the right thing to do.

Other (Please list)

Please indicate how you felt about using the Thru-hiker Registration System?

ATC's Thru-hiker
Registration System was...

Easy Arduous

Understandable Difficult to understand

Not time consuming Time consuming

Worth it Not worth it

Did your first preferred start date show as "full" on the registration system?

Yes

No

I do not recall

Did you change your proposed start date to one that was not "full"?

Yes

No

I do not recall

How much time did you spend online to register your starting date and location?
(In minutes)

If you would have needed to take a Leave No Trace online awareness course as a pre-requisite to register, how much time would you have been willing to take to finish the online course? (In minutes)

Did you start on the date you registered for?

Yes

No

Did you start at the place you registered for?

Yes

No

After your registration, did you receive a green plastic hang tag with Leave No Trace information on it from ATC ?

Yes

No

Did you like the hang tag?

Yes

No

Is there anything you want to add about what you liked or didn't like about the hang tag or information?

Did you display your hang tag when you started?

Yes

No

What were the reasons behind choosing not to display it? (Please select all that apply)

I didn't like it

I didn't have anything to attach it to my pack with

No compelling reason to display it

I didn't know what it was for

I didn't think it would be durable enough to last for the whole trip

Other (Please list)

For what percentage of your most recent A.T. thru- or section hiking trip did you have it displayed?

How did people on the Trail generally react to your hang tag?

Positively

Neutrally

Negatively

How did people in towns generally react to your hang tag?

Positively

Neutrally

Negatively

Did you know about the Thru-hiker Registration System before your most recent A.T. thru- or section hiking?

Yes

No

Would you please tell us why you did not register your trip?

ATC is updating and expanding the Thru-hiker Registration System into an A.T. overnight hiker registration system to help hikers choose less crowded dates to start their hikes. ATC would like to make the registration system as user friendly as possible and would appreciate your input.

How much time would you be willing to spend online to register your starting date and location? (In minutes)

If you needed to take a Leave No Trace online awareness course as a pre-requisite to register, how much time would you be willing to take to finish the online course ? (In minutes)

What might be some incentives that would help motivate you to use ATC's overnight hiker registration system?

What might be some concerns you would have about using ATC's overnight hiker registration system?

Section 7 Information about Lyme Disease

Section 7 Information about Lyme Disease

ATC wants to expand its Lyme disease education efforts to help protect the health of A.T. long distance hikers. Please help inform these efforts by answering the following questions.

Did you contract a tick-borne illness during your most recent A.T. thru- or section hiking trip?

Yes

No

I am not sure

Were you diagnosed with or treated for a tick-borne illness during or after your most recent A.T. thru- or section hiking trip?

Yes

No

Would you be willing to participate in a follow-up survey on Lyme disease at a later date?

Yes

No

Thank you for your willingness. Please send an email to Laurie Potteiger at **lpotteiger@appalachiantrail.org** with "Tick Survey" in the subject line. You might want to highlight and copy the highlighted email address, save it in your clipboard, and send an email to Laurie after you complete the survey.

Section 8 Demographics

Section 8 Demographics

Finally, please help us know more about A.T. long-distance hikers by answering the following basic demographic questions.

In what year were you born?

In what ethnic group would you place yourself?

Hispanic or Latino

Not Hispanic or Latino

In what race group would you place yourself?

Black or African American

Asian American

White

American Indian or Alaskan Native

Native Hawaiian or Other Pacific Islander

Other (Please specify)

What was your total household income (before taxes) the year before your most recent A.T. thru- or section hiking trip?

- Less than \$20,000
- \$20,000 to \$39,999
- \$40,000 to \$59,999
- \$60,000 to \$79,999
- \$80,000 to \$99,999
- \$100,000 or more

What was your ZIP code during your most recent A.T. thru- or section hiking trip?

If you do not live in the U.S., what is your country of residence?

Do you have any final thoughts about the A.T., your A.T. experiences, or the ATC you would like to share?

Appendix C Survey Instrument Two for Chapter Three

This instrument is for participants who registered their intent to thru-hike the Appalachian Trail through the Appalachian Trail Conservancy's Voluntary Thru-hiker Registration System in 2015.

Cover Letter

2016 Appalachian Trail Long Distance Hiker Survey

Hello,

Thank you for agreeing to participate in this study about your experiences with Appalachian Trail Conservancy (ATC) 2015 Thru-Hiker Registration System and the Appalachian Trail (A.T.). The purpose of this study is to gain a better understanding of what A.T. long distance hikers, including you, experienced through the registration system, on the trail, and what you value. The results of this study will help resource managers from the ATC, their agency partners, and the 31 A.T. maintaining clubs develop strategies to more effectively care for the A.T. and support future visitors.

We value your opinions and your privacy. All your responses are anonymous and confidential and results will only be reported as summaries, without any identifying information. Your email address will not be shared with anyone and we will delete it upon completion of our study. Your participation in this study is completely voluntary. Although your responses are very important to us, you may choose to withdraw at any time or not answer particular questions.

If you have any questions or comments about this study, please contact us at tguo@ncsu.edu or (919)575-3687.

Sincerely,

A handwritten signature in black ink that appears to read "Tom Guo".

Qualtrics Survey Software

<https://login.qualtrics.com/ControlPanel/Ajax.php?action=GetS...>

Tian Guo, Ph.D. Candidate



Roger L. Moore, Ph.D.
North Carolina State University

Overall and individual who registered and hiked

Section 1 A.T. Thru-hiker Registration System

First, we would like to learn a bit about your experiences with using the ATC Thru-hiker Registration System.

Where did you first learn about the Thru-hiker Registration System?

- On the ATC website
- From social media (e.g., Facebook pages, twitter)
- From guide books
- From other thru-hikers

Other (Please list)

What was your chief motivation for using the Thru-hiker Registration System?
(Please select all that apply)

I was concerned about possible crowding along the A.T.

A friend recommended it.

I followed the suggestion on the ATC website.

I thought it was the right thing to do.

Other (Please list)

Please indicate how you felt about using the Thru-hiker Registration System:

ATC's Thru-hiker Registration System was...								
Easy	<input type="radio"/>	Arduous						
Understandable	<input type="radio"/>	Difficult to understand						
Not time consuming	<input type="radio"/>	Time consuming						
Worth it	<input type="radio"/>	Not worth it						

Did your first preferred start date show as "full" on the registration system?

Yes

No

I do not recall

Did you change your proposed start date to one that was not "full"?

Yes

No

I do not recall

How much time did you spend online to register your starting date and location?
(In minutes)

If you would have needed to take a Leave No Trace online awareness course as a pre-requisite to register, how much time would you have been willing to take to finish the online course? (In minutes)

Did you attempt your A.T. thru- or section hike in 2015?

Yes

No

Did you start on the date you registered for?

Yes

No

Did you start at the place you registered for?

Yes

No

Section 2 Your Most Recent Long Distance Hike on the Appalachian Trail (A.T.)

We would like to learn a bit about your most recent long-distance hiking trip on the A.T..

Did you complete the entire 2,190 miles of the A.T. in 2015?

Yes

No

How many miles did you hike on A.T. in 2015?

Did you complete the entire A.T. that time by:

Thru-hiking

Section hiking

Qualtrics Survey Software

<https://login.qualtrics.com/ControlPanel/Ajax.php?action=GetS...>

In which direction did you thru-hike the A.T.?

Northbound

Southbound

Flip-flop

ANSWER

Other (Please specify)

What year did you hike the first section of this section hike?

1

Did you sign the A.T. register at the visitor center at Amicalola Falls State Park in Georgia?

Yes

No

Did you sign the A.T. register at the top of Springer Mountain?

Yes

No

What was your level of backcountry experience **before** your most recent A.T. thru- or section hiking trip.

Novice



Expert

Section 3 Attitudes toward the Appalachian Trail (A.T.)

Now, we would like to know how you feel about the A.T. in general.

In general, my attitude toward the A.T. is...

Favorable Unfavorable

Please indicate how you feel about the A.T. by checking one response for each of the following pairs of descriptions:

The A.T. is...									
Natural	<input type="radio"/>	Artificial							
Unique	<input type="radio"/>	Common							
Wilderness-like	<input type="radio"/>	Urban-like							
Quiet	<input type="radio"/>	Noisy							
Safe from crime	<input type="radio"/>	Unsafe from crime							
Scenic	<input type="radio"/>	Unattractive							

On a scale of 1 to 10, with 1 being **completely dissatisfied** and 10 being **completely satisfied**, how satisfied were you with your most recent A.T. thru- or section hiking trip?

Section 4 Recreation Behaviors and Attitudes

Now, we would like to know a little more about what you did during your most recent A.T. thru- or section hiking trip. Remember, all your answers are anonymous and confidential. **Please think about your time on the A.T. during your most recent thru- or section hiking trip when responding to each question.**

On that trip, how many nights did you spend **in the backcountry** (i.e., staying at shelters or camping)?

On that trip, how many nights did you spend **off the A.T.** (e.g., in nearby towns)?

On that trip, how frequently did you **carry out all of your own litter?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **carry out all the litter you found even if others left it before you?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **wash yourself and dishes at least 200 feet away from all streams and the other bodies of water?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **collect any rocks, plants or other natural items to keep?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **collect any cultural artifacts to keep?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **construct a new fire ring?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **write your name on, draw on, or carve on any trees, shelters or other natural or man-made surfaces?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **build a campfire?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **remove limbs from a live or dead tree to use as firewood?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **scatter your campfire ashes prior to leaving your campsite?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **short-cut switchbacks?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **camp on previously used campsites when you camped?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **use a bear canister to store your food and other smellable items?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **hang your food and other smellable items?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

On that trip, how frequently did you **dig a "cathole" to dispose of your human waste when a privie/outhouse was unavailable?**

- Always
- Most of the Time
- Sometimes
- Rarely
- Never

How deep did you usually dig your cathole (in inches)?

1

What tools did you use to dig your catholes (Please select all that apply)?

Trowel

Boot

Sticks

Trekking poles

Tent stake or snow stake

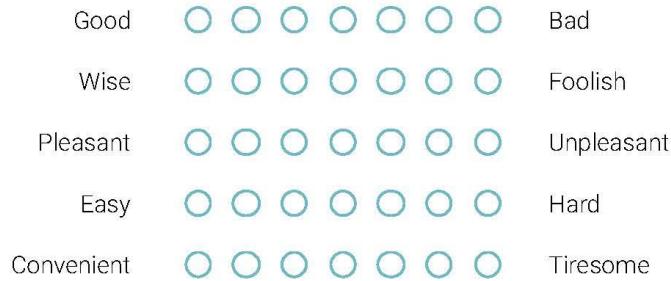
Other (Please specify)

Please indicate how you feel about the following behaviors on the A.T. by checking one response for each of the following questions.:

Using catholes when privies/outhouses are not available is...

Camping only on previously used campsites is...

Using a bear canister to store your food and other smellable items is....

Hanging your food and other smellable items is...**Section 5 Attitudes toward Leave No Trace Principles**

We are also interested in how you feel about the seven Leave No Trace principles. They are:

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

How would you rate your knowledge of Leave No Trace outdoor skills and practices?

I've never heard of them before this survey

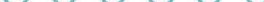
Novice

Intermediate

Advanced

Expert

In general, what is your attitude toward following the Leave No Trace principles when hiking on the A.T. ?

Favorable  Unfavorable

Please indicate how you feel about following the Leave No Trace principles when hiking on the A.T.:

Following the Leave No Trace principles while on the A.T. is...

Good Bad

Wise Foolish

Pleasant ○ ○ ○ ○ ○ ○ Unpleasant

Easy Hard

Convenient Tiresome

To what degree did you feel personally obligated to follow the Leave No Trace principles when you were on the A.T.?

- Not obligated at all
- A little obligated
- Somewhat obligated
- Very obligated
- Completely obligated

To what degree did you feel that following the Leave No Trace principles detracted from your enjoyment during your most recent A.T. thru- or section hiking trip?

- It didn't detract at all
- It detracted a little bit
- It was somewhat detracting
- It was very detracting
- Completely detracting

Which of the following education programs had you ever participated in **prior to** your most recent A.T. thru- or section hiking trip? (Please select all that apply)

- Leave No Trace Awareness workshop
- Leave No Trace on-line awareness course
- Leave No Trace Trainer Course
- Leave No Trace Master Educator Course
- Project WILD Program
- National Outdoor Leadership School (NOLS) course
- Outward Bound Course

Other (Please list)

None of the above

Did you see any Leave No Trace informational materials during your most recent A.T. thru- or section hiking trip? (Please select all that apply)

- No
- Yes, I saw trailhead signage
- Yes, I saw signs/posters in shelters
- Yes, on the hangtag I received when I registered my thru-hike
- Yes I saw Leave No Trace materials in other locations (Please describe)

Do you have any more comments you want to add about Leave No Trace principles on the A.T.?

Section 6 Values

Now, we would like to know a little more about how you value various things in your life. Below are 57 portraits of a person's goals, aspirations, or wishes. Please indicate how much like you is the person.

To begin, please help us personalize the description wording for you. We simply want to be able to match the pronoun in each description to your preference.

What is the gender you identified with?

Male

Female

If you prefer, we can specify your gender descriptor as any other you might prefer (Please specify)

Prefer not to disclose

These page timer metrics will not be displayed to the recipient.

First Click: 0 seconds

Last Click: 0 seconds

Page Submit: 0 seconds

Click Count: 0 clicks

How much like you is this person?

	Definitely not me	Not like me	Hard to say	Somewhat like me	Totally me
Being very successful is important to him	<input type="radio"/>				
He wants people to admire his achievement.	<input type="radio"/>				
He avoids anything that might endanger his safety	<input type="radio"/>				
His personal security is extremely important to him	<input type="radio"/>				
It is important to him to live in secure surroundings	<input type="radio"/>				
It is important to him that his country protects itself against all threats	<input type="radio"/>				
He wants the state to be strong so it can defend its citizens	<input type="radio"/>				
Having order and stability in society	<input type="radio"/>				

Note. The rest 39 value items could be found in Chapter 3 Table 3 Descriptive of respondents values

Section 7 ATC Hang Tag

After your registration at the ATC Thru-hiker Registration System, did you receive a green plastic hang tag with Leave No Trace information on it from ATC ?

Yes

No

Did you like the hang tag?

Yes

No

Is there any thing you want to add about what you liked or didn't like about the hang tag or information?

Did you display your hang tag when you started?

Yes

No

What were the reasons behind choosing not to display it? (Please select all that apply)

- I didn't like it
- I didn't have anything to attach it to my pack with
- No compelling reason to display it
- I didn't know what it was for
- I didn't think it would be durable enough to last for the whole trip

Other (Please list)

For what percentage of your most recent A.T. thru- or section hiking trip did you have it displayed?

How did people on the Trail generally react to your hang tag?

- Positively
- Neutrally
- Negatively

How did people in towns generally react to your hang tag?

- Positively
- Neutrally
- Negatively

Section 8 Information about Lyme Disease

ATC wants to expand its Lyme disease education efforts to help protect the health of A.T. long-distance hikers. Please help inform these efforts by answering the following questions.

Did you contract a tick-borne illness during your most recent A.T. thru- or section hiking trip?

Yes

No

I am not sure

Were you diagnosed with or treated for a tick-borne illness during or after your most recent A.T. thru- or section hiking trip?

Yes

No

Would you be willing to participate in a follow-up survey on Lyme disease at a later date?

Yes

No

Thank you for your willingness. Please send an email to Laurie Potteiger with

ATC at **Ipotteiger@appalachiantrail.org** with "Tick Survey" in the subject line.

You might want to highlight and copy the email address, save it in your clipboard, and send an email to Laurie after you complete the survey.

Section 9 Demographics

Finally, please help us know more about A.T. long-distance hikers by answering the following basic demographic questions.

In what year were you born?

In what ethnic group would you place yourself?

Hispanic or Latino

Not Hispanic or Latino

In what race group would you place yourself?

Black or African American

Asian American

White

American Indian or Alaskan Native

Native Hawaiian or Other Pacific Islander

Other (Please specify)

What was your total household income (before taxes) the year before your most recent A.T. thru- or section hike?

- Less than \$20,000
- \$20,000 to \$39,999
- \$40,000 to \$59,999
- \$60,000 to \$79,999
- \$80,000 to \$99,999
- \$100,000 or more

What was your ZIP code during your most recent A.T. thru- or section hiking trip?

If you do not live in the US, what is your country of residence?

Do you have any final thoughts about the A.T., your A.T. experiences, or the ATC you would like to share?

Individuals who registered but did not hike A.T. in 2015

What might be the reasons behind choosing not to start your A.T. thru- or section hiking in 2015 as you planned?

Do you plan to start your A.T. thru- or section hike in 2016?

Yes

No

Section 2 Values

Now, we would like to know a little more about how you value various things in your life. Below are 57 portraits of a person's goals, aspirations, or wishes. Please indicate how much like you is the person.

To begin, please help us personalize the description wording for you. We simply want to be able to match the pronoun in each description to your preference.

What is the gender you identified with?

Male

Female

If you prefer, we can specify your gender descriptor as any other you might prefer (Please

specify)

Prefer not to disclose

These page timer metrics will not be displayed to the recipient.

First Click: 0 seconds

Last Click: 0 seconds

Page Submit: 0 seconds

Click Count: 0 clicks

How much like you is this person?

	Definitely not me	Not like me	Hard to say	Somewhat like me	Totally me
Being very successful is important to him	<input type="radio"/>				
He wants people to admire his achievement.	<input type="radio"/>				
He avoids anything that might endanger his safety	<input type="radio"/>				
His personal security is extremely important to him	<input type="radio"/>				
It is important to him to live in secure surroundings	<input type="radio"/>				
It is important to him that his country protects itself against all threats	<input type="radio"/>				
He wants the state to be strong so it can defend its citizens	<input type="radio"/>				
Having order and stability in society	<input type="radio"/>				

Note. The rest 39 value items could be found in Chapter 3 Table 3 Descriptive of respondents values

Section 3 Attitudes toward the Appalachian Trail (A.T.)

Now, we would like to know how you feel about the A.T. in general.

In general, my attitude toward the A.T. is...

Favorable  Unfavorable

Please indicate how you feel about the A.T. by checking one response for each of the following pairs of descriptions:

The A.T. is...													
Natural	<input type="radio"/>	Artificial											
Unique	<input type="radio"/>	Common											
Wilderness-like	<input type="radio"/>	Urban-like											
Quiet	<input type="radio"/>	Noisy											
Safe from crime	<input type="radio"/>	Unsafe from crime											
Scenic	<input type="radio"/>	Unattractive											

Section 4 Attitudes toward Leave No Trace Principles

We are also interested in how you feel about the seven Leave No Trace

principles. They are:

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

How would you rate your knowledge of Leave No Trace outdoor skills and practices?

Never heard of it before this survey

Novice

Intermediate

Advanced

Expert

In general, what is your attitude toward following the Leave No Trace principles when hiking on the A.T.?

Favorable  Unfavorable

Please indicate you feel about following the Leave No Trace principles when hiking on the A.T.

Following the Leave No Trace principles while on the A.T. is:

Please indicate you feel about the following behaviors on the A.T. by checking one response for each of the following questions:

Using catholes when privies/outhouses are not available is...

Camping only on previously used campsites is...

Using a bear canister to store your food and other smellable items is...

Hanging your food and other smellable items is...

Good	<input type="radio"/>	Bad
Wise	<input type="radio"/>	Foolish
Pleasant	<input type="radio"/>	Unpleasant
Easy	<input type="radio"/>	Hard
Convenient	<input type="radio"/>	Tiresome

To what degree do you feel personally obligated to follow the Leave No Trace principles on the A.T.?

- Not obligated at all
- A little obligated
- Somewhat obligated
- Very obligated
- Completely obligated

To what degree do you feel that following the Leave No Trace principles would detract from your enjoyment during an A.T. thru- or section hiking trip?

- It would not detract at all
- It would detract a little bit
- It would be somewhat detracting
- It would be very detracting
- Completely detracting

Which of the following education programs have you participated in ? (Please select all that apply)

- Leave No Trace Awareness workshop
- Leave No Trace on-line awareness course
- Leave No Trace Trainer Course
- Leave No Trace Master Educator Course
- Project WILD Program
- National Outdoor Leadership School (NOLS) course
- Outward Bound Course

Other (Please list)

None of the above

Do you have any more comments you want to add about Leave No Trace principles on the A.T.?

Section 5 Demographics

Finally, please help us know more about A.T. long-distance hikers by answering the following basic demographic questions.

In what year were you born?

In what ethnic group would you place yourself?

Hispanic or Latino

Not Hispanic or Latino

In what race group would you place yourself?

Black or African American

Asian American

White

American Indian or Alaskan Native

Native Hawaiian or Other Pacific Islander

 Other (Please specify)

What was your total household income (before taxes) in a typical year?

Less than \$20,000

\$20,000 to \$39,999

\$40,000 to \$59,999

\$60,000 to \$79,999

\$80,000 to \$99,999

\$100,000 or more

What is your ZIP code?

If you do not live in the US, what is your country of residence?

Do you have any final thoughts about the A.T., your A.T. experiences, or the ATC you would like to share?

Appendix D Pre-Notice Survey Invitation and Follow-up Reminders for Chapter Three

These contact materials were for participants who registered their completed hike through Appalachian Trail Conservancy in 2014 and 2015. The first contact email was sent on behalf of Appalachian Trail Conservancy. The survey invitation and reminders were sent out on behalf of the research team. Each contact email was designed to visually appeal to viewers. Wording in these contact materials were slightly adjusted for potential participants who registered their intent to thru-hike the Appalachian Trail through the Appalachian Trail Conservancy's Voluntary Thru-hiker Registration System in 2015.

Pre-Notice



Dear Recent 2000-Miler,

First of all, congratulations on completing the entire Appalachian Trail! Yours is a notable accomplishment and one worth celebrating. I am contacting you now because the Appalachian Trail Conservancy (ATC) has partnered with researchers from North Carolina State University, Tian Guo and Roger Moore, to conduct a study designed to help us better understand A.T. long distance hikers' experiences and attitudes. By participating in this study you will be helping us accomplish our mission of preserving and managing the A.T. now and for future generations.

When you registered your completion with ATC you indicated that you would be willing to be contacted by email for research efforts related to the A.T. Participation in this study is voluntary and your responses will remain completely anonymous and confidential.

In the upcoming week, you will receive an email from Qualtrics, the on-line survey platform the researchers are using for this study. The address in the "from" line will be noreply@gemailserver.com and the subject line will be "**2016 Appalachian Trail Long Distance Hiker Survey**". That email will give you a unique access to the survey.

It will take about 25 minutes of your time. Your investment of time through participating in this study is extremely important to the Trail and the A.T. long distance hiker community.

Thank you for your time and ongoing support of the Appalachian Trail!

Laurie Potteiger
Information Services Manager
Appalachian Trail Conservancy
799 Washington Street | P.O. Box 807
Harpers Ferry, WV 25425-0807
Phone: [304.535.2200](tel:304.535.2200) x128
lpotteiger@appalachiantrail.org
www.appalachiantrail.org

Survey Invitation

Hello [First Name of the Email Holder]!

We are researchers at North Carolina State University, working with the Appalachian Trail Conservancy (ATC) to better understand Appalachian Trail long distance hikers' experiences and attitudes. We invite you, an important member of the A.T. hiker community, to share with us what you experienced on the trail and what you value. Your participation will help resource managers from the ATC, their agency partners, and the 31 A.T. maintaining clubs develop strategies to more effectively care for the A.T. and support future visitors.

Follow this link to the Survey:

[Take the Survey](#)

Or copy and paste the URL below into your internet browser:

https://ncsu.qualtrics.com/SE?Q_DL=3snmLAm98qwx2Wp_2iCmwzmralLUxIX_MLRP_d4ig9KnbdVJFnk9&Q_CHL=email

The survey will take about 25 minutes to complete. We value your opinions and your privacy. All your responses are anonymous and confidential and results will only be reported as summaries. We will not share your email address with anyone and we will delete it upon completion of our study. Your participation in this study is voluntary. Although your responses are very important to us, you may choose to withdraw at any time or not answer particular questions. There are no known risks involved in your participation in this research.

If you have any questions or comments about this study or want to be removed from our sample list, please contact us at NC State University, through Tian Guo at tguo@ncsu.edu.

Best Regards,

Tian Guo
Research Assistant
Department of PRTM
North Carolina State University

Dr. Roger Moore
Associate Professor
Department of PRTM
North Carolina State University

Follow-up Email #1

Sent out A week after the initial email.

Hello again [First Name of the Email Holder],

We recently sent you an email about our important 2016 Appalachian Trail Long Distance Hiker study and invited you to share about what you experienced on the A.T. and what you value. If you have already completed the survey, we appreciate your support! If you have not yet responded to the survey, we encourage you to take about 25 minutes and complete the survey.

Follow this link to the Survey:

[Take the Survey](#)

Or copy and paste the URL below into your internet browser:

https://ncsu.qualtrics.com/SE?Q_DL=3snmLAm98qwx2Wp_2iCmwzmralLUxlX_MLRP_d4ig9KnbdVJFnk9&Q_CHL=email

Please participate to help us gain a better understanding of the culture of the A.T. long-distance hiker community and to help resource managers from the Appalachian Trail Conservancy (ATC), their agency partners, and the 31 A.T. maintaining clubs develop strategies to more effectively care for the A.T. and support future visitors.

If you have any questions or comments about this study or want to be removed from our sample list, please contact us at North Carolina State University, through Tian Guo at tguo@ncsu.edu.

Many thanks,

Tian Guo
Research Assistant
Department of PRTM
North Carolina State University

Dr. Roger Moore
Associate Professor
Department of PRTM
North Carolina State University

Follow-up Email #2

Sent out two weeks after the initial email

Hello again [First Name of the Email Holder],
Your participation in the 2016 Appalachian Trail Long Distance Hiker Survey is still needed!
We understand how valuable your time is. Your investment of about 25 minutes will help us to gain a better understanding of what A.T. long distance hikers, including you, experienced on the trail and what you value. Most importantly, your responses will help planners and resource managers from the Appalachian Trail Conservancy (ATC), their agency partners, and the 31 A.T. maintaining clubs to more effectively care for the A.T. and support future visitors.

Follow this link to the Survey:

[Take the Survey](https://ncsu.qualtrics.com/SE?Q_DL=8GJ3Mb9L9FRSPXf_5bzwDt2ATCRNPZb_MLRP_eX8Mu9ynwfWv0Wh&Q_CHL=email)

Or copy and paste the URL below into your internet browser:

https://ncsu.qualtrics.com/SE?Q_DL=8GJ3Mb9L9FRSPXf_5bzwDt2ATCRNPZb_MLRP_eX8Mu9ynwfWv0Wh&Q_CHL=email

Thank you in advance for completing the survey. Your responses are important!
If you have any questions or comments about this study or want to be removed from our sample list, please contact us at North Carolina State University, through Tian Guo at tguo@ncsu.edu.
Sincerely,

Tian Guo
Research Assistant
Department of PRTM
North Carolina State University

Dr. Roger Moore
Associate Professor
Department of PRTM
North Carolina State University

Follow-up email #3

Sent out on the last day that the survey will be open, about three weeks after the initial email.

Hello one last time [First Name of the Email Holder],
The 2016 Appalachian Trail Long Distance Hikers Survey will be ending soon. We still need your participation! This is a final chance for you to share your experiences and opinions through this study with researchers, resource managers from the Appalachian Trail Conservancy (ATC), their agency partners, and the 31 A.T. maintaining clubs. It will only take you about 25 minutes to fill out the survey.

Follow this link to the Survey:

[Take the Survey](#)

Or copy and paste the URL below into your internet browser:

https://ncsu.qualtrics.com/SE?Q_DL=8GJ3Mb9L9FRSPXf_5bzwDt2ATCRNPZb_MLRP_eX8Mu9ynwfWv0Wh&Q_CHL=email

This is the last reminder we send to you. If you have any questions or comments about this study, please contact us at North Carolina State University, through Tian Guo at tguo@ncsu.edu.

Sincerely,

Tian Guo
Research Assistant
Department of PRTM
North Carolina State University

Dr. Roger Moore
Associate Professor
Department of PRTM
North Carolina State University

Illustration of the Visual Design of the Follow-up Reminders



March, 2016

Appalachian Trail Long Distance Hiker Survey



Hello one last time Tian,

The 2016 Appalachian Trail Long Distance Hikers Survey will be ending soon. We still need your participation! This is a **final** chance for you to share your experiences and opinions through this study with researchers, resource managers from the Appalachian Trail Conservancy (ATC), their agency partners, and the 31 A.T. maintaining clubs.

Follow this link to the Survey:

[Take the Survey](#)

Or copy and paste the URL below into your internet browser:

https://ncsu.qualtrics.com/SE?Q_DL=8GJ3Mb9L9FRSPXf_5bzwDt2ATCRNPZb_MLRPeX8Mu9vnwfWv0Wh&Q_CHL=email

This is the last reminder we send to you. If you have any questions or comments about this study, please contact us at NC State University, through Tian Guo at tguo@ncsu.edu.

Sincerely ,

Tian Guo
Research Assistant
Department of PRTM
NC State University

Dr. Roger Moore
Associate Professor
Department of PRTM
NC State University

[Tian Guo, Ph.D. Candidate | Roger Moore, Ph.D.](#)

Follow the link to opt out of future emails:

[Click here to unsubscribe](#)

Appendix E Summaries of Attitudinal Factors for Chapter Three

Table E1. Summaries of respondents' attitudes toward digging a cathole when privies/outhouses are not available.

		Mean	S.D.
Good	Bad	2.5	1.1
Wise	Foolish	2.6	0.9
Pleasant	Unpleasant	0.6	1.7
Easy	Hard	0.7	1.7
Convenient	Tiresome	0.4	1.7

Note. Attitudes were measured with seven-point bi-polar scales, with 3 as the most positive score and -3 as the most negative score.

Table E2. Summaries of respondents' attitudes toward camping only on previously used campsites

		Mean	S.D.
Good	Bad	2.5	1.0
Wise	Foolish	2.5	1.0
Pleasant	Unpleasant	2.0	1.2
Easy	Hard	2.4	1.0
Convenient	Tiresome	2.2	1.1

Note. Attitudes were measured with seven-point bi-polar scales, with 3 as the most positive score and -3 as the most negative score.

Table E3. Summaries of respondents' attitudes toward using a bear canister to store food and other smellable items

		Mean	S.D.
Good	Bad	1.4	1.7
Wise	Foolish	1.3	1.8
Pleasant	Unpleasant	- 0.1	1.9
Easy	Hard	- 0.7	2.0
Convenient	Tiresome	- 1.0	1.9

Note. Attitudes were measured with seven-point bi-polar scales, with 3 as the most positive score and -3 as the most negative score.

Table E4. Summaries of respondents' attitudes hanging food and other smellable items

		Mean	S.D.
Good	Bad	2.6	0.9
Wise	Foolish	2.6	1.0
Pleasant	Unpleasant	1.0	1.6
Easy	Hard	0.6	1.7
Convenient	Tiresome	0.1	1.8

Note. Attitudes were measured with seven-point bi-polar scales, with 3 as the most positive score and -3 as the most negative score.

Table E5. Summaries of respondents' attitudes toward following LNT behavior during most recent thru- or section hiking trip.

		Mean	S.D.
Favorable ^a	Unfavorable	6.8	0.5
Good ^b	Bad	2.9	0.3
Wise	Foolish	2.9	0.4
Pleasant	Unpleasant	2.4	0.9
Easy	Hard	1.8	1.2
Convenient	Tiresome	1.5	1.3

a. Attitudes were measured with seven-point bi-polar scales, with 1 as the most favorable score and 7 as the most unfavorable.

b. The attitudes was measured with seven-point bi-polar scales, with 3 as the most positive score and -3 as the most negative score.

Table E6. Summaries of respondents' attitudes toward the Appalachian Trail

		Mean	S.D.
Favorable	- Unfavorable	6.6	1.0
Natural	- Artificial	1.9	1.0
Unique	- Common	2.3	1.0
Wilderness-like	- Urban-like	1.5	1.1
Quit	- Loud	1.4	1.2
Safe from crime	- Unsafe from crime	2.1	0.9
Scenic	- Unattractive	2.2	0.9

Appendix F Pre-test Survey Instrument for Chapter Four

The 2016 Appalachian Trail Hiking and Trail Conditions Study Pre-Experiment Survey

These page timer metrics will not be displayed to the recipient.

First Click: 0 seconds

Last Click: 0 seconds

Page Submit: 0 seconds

Click Count: 0 clicks

Please watch the video below and read the information about low impact hiking behavior on the Appalachian Trail that follows just after the video. After that, please answer the five questions at the end of this survey.

It is important to always stay in the middle of the trail while you are hiking in heavily used areas like much of the Appalachian Trail.

Remember to:

- Walk through any puddles, mud, or rugged spots on the trail, rather than walk around them. This reduces trail widening and erosion.
- Walk on wood or stone steps rather than around them.

obstacles such as fallen branches to reduce trail widening.

Have you seen this video before today?

Yes

No

Which of the following hiking behaviors were recommended in the video and statements you just read? (**Check all that apply**)

If there is a mud puddle in the middle of the trail, get muddy and walk right through it

If you encounter wood or stone steps, walk on them rather than around them

If the trail is not totally dry, choose the wet part to step on rather than walking on dry barren soil or grasses along the edges

Now that you have watched the video and read the related statements, how do you feel about **walking through any puddles, mud, or rugged spots on the trail, rather than walking around them?**

Good	<input type="radio"/>	Bad
Wise	<input type="radio"/>	Foolish
Pleasant	<input type="radio"/>	Unpleasant
Easy	<input type="radio"/>	Hard
Convenient	<input type="radio"/>	Tiresome
Necessary	<input type="radio"/>	Not necessary

Now that you have watched the video and read the related statements, how do you feel about **walking on wood or rock steps rather than around them?**

Good	<input type="radio"/>	Bad
Wise	<input type="radio"/>	Foolish
Pleasant	<input type="radio"/>	Unpleasant
Easy	<input type="radio"/>	Hard
Convenient	<input type="radio"/>	Tiresome
Necessary	<input type="radio"/>	Not necessary

Finally, please enter your last name and email address for the purpose of verification.

Last Name

Email address

Thank you for answering these questions! Click the "Submit" button to provide us with your answers. We look forward to seeing you at the Geovisualization Laboratory on the 5th floor (room 5111) of Jordan Hall,

If you have any questions or comments about this study, please feel free to contact Tian Guo at tguo@ncsu.edu.

Appendix G Post-test Survey Instrument for Chapter Four

Participant ID

If the participant does not show up, or too late to conduct the session, please note here.

Gender of the participant

Male

Female

Post-experiment survey starts at next screen.

Post experiment survey

2016 Appalachian Trail Hiking and Trail Condition Study Post-Experiment Survey

Now, how do you feel about **walking on wood or rock steps rather than around them**? Indicate your response for Each pair of words below.

Good	<input type="radio"/>	Bad
Wise	<input type="radio"/>	Foolish
Pleasant	<input type="radio"/>	Unpleasant
Easy	<input type="radio"/>	Hard
Convenient	<input type="radio"/>	Tiresome
Necessary	<input type="radio"/>	Not necessary

Please indicate your level of agreement with following five statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I should always stay on officially constructed trails	<input type="radio"/>				
It is ok to hike on the edge of a trail if it is more convenient and comfortable	<input type="radio"/>				
The environmental impact of hiking on the edge of a trail is minimal	<input type="radio"/>				
I should be able to decide where on the trail I want to walk	<input type="radio"/>				
I don't like to be told what the appropriate hiking behavior is	<input type="radio"/>				

These page timer metrics will not be displayed to the recipient.

First Click: 0 seconds

Last Click: 0 seconds

Page Submit: 0 seconds

Click Count: 0 clicks

How much like you is this person?

	Definitely not me	Not like me	Hard to say	Somewhat like me	Totally me
Being very successful is important to her.	<input type="radio"/>				
She wants people to admire her achievement.	<input type="radio"/>				
She avoids anything that might endanger her safety	<input type="radio"/>				
Her personal security is extremely important to her	<input type="radio"/>				
It is important to her to live in secure surroundings	<input type="radio"/>				
It is important to her that her country protect itself against all threats	<input type="radio"/>				
She wants the state to be strong so it can defend its citizens	<input type="radio"/>				
Having order and stability in society is important to her	<input type="radio"/>				

Note. The rest 39 value items could be found in Chapter 3 Table 3 Descriptive of respondents values

How often do you hike, walk, or run on unpaved trails?

- Never
- 1-5 times a year
- 6-10 times a year
- More than 10 times a year

What is your level of backcountry experience?

Novice Expert

Have you ever hiked on the Appalachian Trail?

- Yes
- No
- I'm not sure

In what state or states have you hiked on the Appalachian Trail?

About how many miles have you hiked on the Appalachian Trail?

In what ethnic group would you place yourself?

Hispanic or Latino

Not Hispanic or Latino

In what race group would you place yourself?

Black or African American

Asian American

White

American Indian or Alaskan Native

Native Hawaiian or Other Pacific Islander

Other (Please specify)

In what year were you born?

What is your major at NC State?

PRTM - Program Management

PRTM - Tourism and Commercial Management

PRTM - Park & Natural Resource

Sport Management

Professional Gold Management

My major is not listed here (please specify)

Do you have any final thoughts about this study or your experiences with this study you would like to share?

Thank you for your participation! Click on "next" button to provide us with your answers.

If you have any questions, please contact Tian Guo at tguo@ncsu.edu, or Dr. Roger Moore at 919.515.3698.

Appendix H Figures of Researcher's Position during Experiment For Chapter Four

Figure F1. Positions of researcher and the participant during pre-test.



Figure F2. Positions of researcher during the drawing task.



Figure F3. Position of the researcher during the post-test.