UNDERSTANDING HIKERS' BEHAVIORAL INTENT TOWARDS LEAVE NO TRACE IN GREAT SMOKY MOUNTAINS NATIONAL PARK

A thesis presented to the faculty of the Graduate School of Western Carolina University in partial fulfillment of the requirements for the degree of Experiential and Outdoor Education

By

David McDowell Schafer

Director: Andrew J. Bobilya
Director of Experiential and Outdoor Education
Department of Human Services

Committee Members: Dr. Andrew J. Bobilya, Experiential and Outdoor Education
Dr. Jeremy Schultz, Experiential and Outdoor Education
Mr. Ben Lawhon, Recreation Solutions Group

March 2022

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ABSTRACT

UNDERSTANDING AND INFLUENCING HIKERS' BEHAVIORAL INTENT TOWARDS LEAVE NO TRACE IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

David Schafer, M.S.

Western Carolina University (March 2022)

Director: Dr. Andrew J. Bobilya

Resource degradation is a primary concern related to increased visitor use of U.S. public lands. This can manifest in vegetation loss, soil compaction and erosion, degradation of water quality, and wildlife disturbance. The Seven Leave No Trace (LNT) Principles are a primary means of educating visitors to reduce impact on public lands. Given that Great Smoky Mountains National Park (GRSM) is the most visited National Park in the country at 14.1 million visitors in 2021, there is a need to replicate previous LNT research conducted in other parks and protected areas in GRSM. This study sought to understand GRSM hikers' behavioral intent towards LNT practices. A quantitative questionnaire was used to measure participants' behavioral intent based on four variables towards LNT: attitudes of appropriateness, perceived effectiveness, perceived difficulty, and self-reported knowledge. A total of 285 questionnaires were completed. Findings show the variables had varying levels of influence on hikers' behavioral intent, with perceived effectiveness and difficulty having the most influence. Based on this, GRSM staff may reduce hiker impact hiker by focusing education on the effectiveness and ease of practice of LNT Principles foremost. Supplementally, staff can provide education that increases hikers' understanding of impacts and emphasizes appropriateness of proper LNT behavior. Better

practice of LNT by hikers in the Park may minimize recreation-related impacts in GRSM and may subsequently improve visitor experience.

Keywords: Great Smoky Mountains National Park, Leave No Trace, theory of planned behavior, hikers

CHAPTER ONE: INTRODUCTION

Introduction

The Great Smoky Mountains National Park (GRSM) is situated within a day's drive of one-half the population of the United States and was visited more than 14.1 million times in 2020 (Visitor Experience Stewardship, 2022). This is a 57% increase in annual visitation rates since 2012 and makes it by far the most visited National Park in the entire United States (Visitor Experience Stewardship, 2022). Resource degradation is a primary concern related to the documented increase in visitor use of public lands. This can manifest in vegetation loss, soil compaction and erosion, degradation of water quality, and wildlife disturbance. (Arrendondo et al., 2021; Marion et al., 2016).

Most land managers have the dual mandates to conserve and protect public lands while promoting access to the public (Marion & Reid, 2001). Managers achieve these mandates and address ecological impacts through two main strategies: direct and indirect management. Direct management strategies involve the enforcement of regulations and may restrict of use of access to conserve public lands, but generally limits visitor autonomy and can create conflict (Dawson & Hendee, 2009). Rather than directly controlling visitors through enforcement or regulations, indirect management emphasizes influencing behavior through more "light-handed" methods such as education and persuasive messaging (Dawson & Hendee, 2009; Hammitt et al., 2015). The use of indirect management focuses on expanding visitor awareness of potential negative impacts and encourages visitors to learn and apply low-impact skills and ethics (Marion, 2016). Leave No Trace (LNT) messaging is an important part of indirect management strategy and is widely utilized by agencies and organizations across many land designations and geographic locations (Marion, 2014).

The expanded use of LNT Principles to educate visitors across various public lands means that further research should be conducted in order to improve its efficacy. Given that GRSM is the most visited National Park in the country, there was need to replicate previous LNT-focused research in the Park. Therefore, the purpose of this study was to explore hikers' behavioral intentions towards LNT Principles in GRSM. This study replicated past LNT research to provide important information for parks in the eastern United States and to inform educational efforts by GRSM staff and the Leave No Trace organization, the non-profit organization that manages LNT efforts in the U.S. and abroad.

History of Leave No Trace

The Seven Leave No Trace (LNT) Principles are one of the most prominent and widely used educational messages for environmentally responsible outdoor recreation in the U.S. and abroad (Lawhon et al., 2017; Taff et al., 2014). The Seven Principles are designed to educate outdoor recreationists about the potential ecological impacts of recreation and teach them skills and techniques to reduce these impacts.

The formation of LNT curriculum came from a need to educate recreationists on low-impact practices in the backcountry. Use of public lands in the U.S. began increasing in the 1960s due to the rising popularity of outdoor activities such as hiking, backpacking, and camping. This trend continued into the 1970s and 1980s, causing increased impact to the natural environments that visitors frequented. These impacts necessitated the creation of educational programs that

Leave No Trace Principles:

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

Figure 1 – The Seven Leave No Trace Principles (Leave No Trace Center, 2021b)

would become the precursor to modern Leave No Trace education. Work by the U.S. Forest Service (USFS), Bureau of Land Management (BLM) and National Park Service (NPS) in the late 1970s and early 80s eventually coalesced into a more standardized version of "No Trace" curriculum. They emphasized educational approaches to changing visitor behavior rather than regulatory or law enforcement-based approaches that could antagonize visitors and be difficult to enforce (Marion & Reid, 2001).

In 1990, the USFS partnered with NOLS (then known as the National Outdoor Leadership School) to develop a written LNT curriculum with the intention of creating a national program. With this partnership, the LNT program oriented towards a science-based approach through collection of relevant literature and consultation with scientists. NOLS was also fundamental in the creation of the experiential training that became the first five-day LNT Master Educator course. Shortly after, the program was formally adopted by the BLM, NPS, and U.S. Fish and Wildlife Service (USFWS) (Leave No Trace Center, 2021a; Marion & Reid, 2001).

In 1994, the non-profit Leave No Trace, Inc. (now known as the Leave No Trace organization) was created to oversee research, funding, and projects related to LNT (Marion & Reid, 2001). The LNT organization is responsible for developing and expanding LNT training and educational resources. It achieves this by conducting research that impacts public lands, and by engaging with federal land management agencies, outdoor industry corporations, nonprofit environmental, outdoor education organizations, and the general public (Leave No Trace, 2021a).

Today, the Seven LNT Principles have been adapted to apply to almost any outdoor setting or activity to help visitors to minimize impacts. While its roots are in backcountry and wilderness settings, the program has expanded to include frontcountry settings (Leave No Trace,

2021a; Marion & Reid, 2001). In addition to its continued partnerships with federal land agencies, the LNT organization entered a Memorandum of Understanding (MOU) with America's State Parks in 2009, representing over 8,000 state parks. The LNT program has also been adopted internationally by countries such as Ireland, New Zealand, Canada, Australia, Montenegro, Hong Kong, South Korea, Greece, Scotland, Argentina, Mexico, and Taiwan. These partnerships will continue to strengthen the LNT organization's efforts to expand LNT curriculum and provide greater opportunity for consistent educational messaging to all types of outdoor recreationists (Lawhon et al., 2017; Vagias & Powell, 2010).

Visitors' Attitudes, Perceptions, and Behavioral Intent towards LNT

Historically, land managers primarily promoted LNT messaging to backcountry users. However, due to the steady increase of public land use by frontcountry users, including day-hikers, there has been a push over the past 15 years to provide LNT messaging for these demographics (Marion, 2014). As such, there has been an increase in LNT research on frontcountry day-use visitors to public lands. The LNT organization, along with various partners in academia and public land management, has conducted numerous studies on visitors' attitudes, perceptions, and behavioral intent towards LNT Principles as they pertain to outdoor recreation (Coulson et al., 2021; Lawhon et al., 2013, 2017, 2019; Taff et al., 2011, 2014). Understanding of these variables helps educators and land managers ensure their LNT educational messages are effective (Lawhon et al., 2017; Taff et al., 2014). Additionally, these studies provide an understanding of behavioral intent towards LNT within specific geographic regions and help discern differences in intentions between different types of recreationists such as day-hikers versus backpackers (Taff et al., 2014).

The preponderance of LNT-focused research to date has been conducted in the western U.S. While studies from other geographic locations can be used to guide LNT messaging in the eastern United States, it is beneficial to replicate research on public lands such as GRSM to capture a wide swath of data on visitor perceptions, attitudes, behavioral intentions, and self-reported practice of LNT (Lawhon et al., 2017; Taff et al., 2014). (Lawhon, et al., 2017; Taff et al., 2014). This is especially true in areas separated by large geographic distances. For example, an LNT study on visitors' behavioral intentions in Wyoming, while certainly useful, may not be generalizable to visitors' behavioral intention in North Carolina or other eastern states.

Prior to this study, no research had been conducted on visitor attitudes, perceptions, and behavioral intentions towards LNT in GRSM. Addressing the lack of LNT-specific research is especially pressing given GRSM's high visitation rates. GRSM is situated within a day's drive of between one-third and one-half the population of the United States and was visited more than 14.1 million times in 2020 (Visitor Experience Stewardship, 2022). This is a 57% increase in annual visitation rates since 2012. It is by far the most visited National Park in the entire United States (Visitor Experience Stewardship, 2022). Considering GRSM's proximity to a large density of the United States' population, along with its high visitation rates, a study on visitor attitudes, perceived difficulty of LNT, perceived effectiveness of LNT, self-reported knowledge, and behavioral intent towards LNT is vital to assist Park staff in their understanding of visitor behavioral intentions, and subsequent implementation of LNT educational strategies.

CHAPTER 2: LITERATURE REVIEW

Literature Review

Ecological Impact Due to Visitor Use

Before addressing visitor attitudes, perceptions, and behavioral intent towards LNT, it is necessary to examine studies that have documented ecological impact due to visitor behavior. A better understanding of this will provide context for the necessity of LNT education in public lands. Ecological impacts can be summarized into four main categories: 1) Vegetation and soil impact, 2) campfire impact, 3) water quality degradation, 4) and wildlife disturbance (Marion et al., 2016).

Vegetation and Soil Impact

Vegetation impact is categorized into three levels: light, intermediate, and heavy trampling. Light trampling is characterized by reduction in height and loss of ground cover of vegetation, whereas intermediate and heavy trampling are characterized by greater loss of coverage, inhibition of native plant regrowth, and increased growth of non-native or invasive species (Marion et al., 2016; Pescott & Stuart, 2014). Level of impact is also influenced by factors such as vegetation resistance and resilience. Resistance is the capacity of vegetation to withstand the direct effects of trampling. Resilience is the capacity of vegetation to recover from trampling damage (Hammit et al., 2015). While some plant types, such as grasses and sedges, have greater resistant and/or resilience, high levels of trampling will generally remove all vegetation cover (Monz et al., 2010). Most vegetation loss occurs during initial traffic on otherwise pristine areas. After initial impact, further traffic has little effect on vegetation coverage or loss if visitors stay on previously impacted sites (Marion et al., 2016).

In addition to loss of vegetation ground cover and increased soil erosion, impact to woody shrubs or mature trees will also occur. This manifests through mechanical damage such as removing limbs, driving nails into trunks, peeling bark, or hacking and felling trees. These impacts have varying degrees of effects on tree health. Most actions (with the exception of felling) will not directly cause tree mortality. Instead, they will increase the likelihood of weakening trees, which will make them more prone to breakage or other adverse effects that are dependent on environmental factors such as drought rate or soil quality (Hammit et al., 2015). Regardless of whether damage has direct contribution to mortality, research shows that long-term impacts can result in a reduction and loss of the forest canopy (Marion et al., 2016). Once loss of vegetation has occurred, issues then extend into soil erosion.

Similar to vegetation, soil erosion is categorized into three levels of impact due to foot traffic: light, intermediate, and heavy trampling (Marion et al., 2016). Light trampling has little effect on soil itself, even if plant life and organic matter are affected. However, intermediate and heavy trampling will result in soil compaction that inhibits plant growth and decreases water permeability (Alessa & Earnhart, 2000). This can lead to pooling water and trail erosion that contributes to soil loss and harms the visitor experience (Leung & Marion, 1999). Off-trail travel and campsite proliferation represent some of the primary visitor behaviors that land managers attempt to mitigate. Visitors tend to travel off trail to points of interest that don't already have trail access and create campsites in flat areas that are close to attractive features such as water sources, points of interests, or viewpoints (Arrendondo et al., 2021; Marion et al., 2016). Visitors may also create new campsites when designated sites have undesirable resource or social conditions (Leung & Marion, 1999).

Campfire Impact

In addition to foot traffic, campfires can impact soil quality by promoting loss of soil nutrients and by creating change in the chemical properties of soil. Alteration of soil properties can inhibit soil and plant recovery on direct campfire sites for 10-15 years after the initial creation of a campfire (Marion et al., 2016). As such, unnecessary campfires at established campsites represent another factor that land managers attempt to mitigate regarding soil damage (Arrendondo et al., 2021; Leung & Marion, 1999; Marion et al., 2016).

Studies by Leung & Marion (1999) and Arrendono et al., (2021) characterized backcountry campsite impacts in GRSM. Reid & Marion (2005) explored campfire impact specifically. Research on campfire impact indicates that, in addition to the soil and flora damage outlined above, cutting of trees and branches is a consistent behavior among hikers when there is an inadequate supply of downed wood, or when hikers ignore or are unfamiliar with best practices of gathering firewood (Reid & Marion, 2005). This extends the potential impact of improper campfires beyond just soil damage.

Water Quality Degradation

Water impacts can be categorized as physical, biological, or chemical. Physical impacts most often occurs due to disturbance such as hiking, horseback riding, use of off-road vehicles, or accessing fishing or swimming areas (Hammit et al., 2015). This can affect water sources by altering temperature and flow rate, increasing turbidity, and increasing erosion. Biological impacts typically occur through two main ways: 1) introduction or spread of nonnative flora and fauna, and 2) increases in coliform bacteria such as E. coli and protozoa such as Giardia lamblia (Reed & Rasnake, 2016). Chemical impacts involve pollution impacts from soap, sunscreen, food particles, and human and animal waste (Ursem et al., 2009).

Research specific to GRSM has focused on biological impact due to effect it may have on small, yet significant water sources such as springs or creeks. Reed & Rasnake (2016) sampled water sources from a total of 10 Appalachian Trail shelters (designated facilities for overnight camping along the A.T. in GRSM) in GRSM to determine the current risk of infectious water from those sites. All water sources were springs or small creeks near each shelter location. Seven of the ten samples were positive for coliform bacteria, and six of those seven were also positive for E coli during summer months. In the fall months, three of seven samples were positive for coliform bacteria and one of those three were positive for E coli (Reed & Rasnake., 2016). While the study could not determine the source of each site's contamination, they theorized that it was likely due to fecal contamination from humans or nearby wildlife. Other research supports this theory of waste contamination in water sources (Ells & Monz, 2011). Regardless, given that the Appalachian Trail is one of the most visited sections in GRSM, this confirms the potential degradation of water source quality along popular sections of GRSM.

Wildlife Disturbance

As visitation to public lands increases, so do potential issues regarding wildlife. Human impact to wildlife is categorized in four ways: exploitation, disturbance, habitat alteration, and pollution (Hammitt et al., 2015; Marion et al., 2016). Exploitation and disturbance are defined by their direct impact to wildlife due to human activity. Exploitation results in immediate death of wildlife (i.e., hunting or accidental vehicle collision), whereas disturbance typically forces wildlife to relocate to less desirable habitats due to harassment from visitors. (Cole & Landres., 1996; Hammitt et al., 2015). While some exploitation and disturbance behaviors may be intentional, the majority is done by visitors who unknowingly or unwittingly stress or harm wildlife. Habitat alteration and pollution are therefore defined as indirect impacts to wildlife

(Marion et al., 2016). Habitat alteration denotes changes to soil, water, flora, and fauna caused by physical or mechanical impacts such as trail construction, roads, or other factors that impact wildlife ecosystems, and increase likelihood of human proximity to animal habitat (Hammit et al., 2015). Relatedly, pollution affects soil, water, flora, and fauna through introduction of trash, human waste, or chemical pollutants such as gasoline (Knight & Gutzwiller, 1995).

Direct and indirect impacts to wildlife may either pose immediate harm or death to wildlife or increase impact and destruction to habitat. By extension, these impacts may alter behavior of individual wildlife and greater populations. Examples of altered behavior include avoidance of suitable habitat near human activity, increased stress and energy expenditure, altered feeding habits, and aggressive behavior in large animals such as bears (Hammit et al., 2015). As a result, this can diminish species populations and increase the likelihood of negative or dangerous encounters between humans and wildlife (Hammit et al., 2015; Knight & Gutzwiller, 1995; Marion et al., 2016).

Managing for Ecological Impact

Vegetation, soil, water, and wildlife are interconnected factors. Rarely does visitor behavior affect only one resource without impacting any of the others. Land managers face the challenge of balancing issues of conservation with public access. Managers have multiple options at their disposal, including regulations, law enforcement, and education. The following section provides a brief explanation of common methods of impact reduction and delve into studies that explore visitor attitudes, perceptions, and behavioral intentions towards LNT practices.

Direct and Indirect Management

Many land managers have the dual mandate to conserve and protect public lands while promoting access to the public (Marion & Reid, 2001). Mitigating visitor ecological impact is typically done via direct and indirect management (Marion et al., 2016).

Direct management regulates visitor behavior through enforcement of regulations, or restrictions of use or access (Dawson & Hendee, 2009). Examples include prohibiting campfires, limiting group size, limiting length of stay at sites, or restricting certain activities or types of use. In rarer situations, managers may ban camping or altogether close all access to natural areas that have received heavy recreation-related impacts. While direct management can effectively change visitor behavior, there is a greater potential for conflict and controversy with the public when using such management techniques (Park et al., 2008). Therefore, indirect management should generally be applied first (Dawson & Hendee, 2009; Marion, 2016).

Indirect management is characterized by the influence of visitor behavior through education, interpretation, and on-site contacts to mitigate ecological impact (Park et al., 2008). Rather than directly controlling visitors through enforcement or regulations, indirect management emphasizes influencing behavior through more "light-handed" methods such as education and persuasive messaging. The use of indirect management focuses on expanding visitor awareness of potential negative impacts and encouraging visitors to learn and apply skills such as LNT (Dawson & Hendee, 2009; Marion, 2016). Indirect management techniques that put emphasis on education and promote self-efficacy in visitor behavior change are well-equipped to help land managers succeed in their efforts towards reducing ecological impact that result from recreation (Dawson & Hendee, 2009; Hammitt et al., 2015; Marion, 2016). Because of this, indirect management is generally the preferred method by both land managers and the recreating

public. Therefore, application of LNT is greatly influenced by the philosophy and approaches characteristic to indirect management (Lawhon et al., 2017).

Theory of Planned Behavior

The Theory of Planned Behavior has been fundamental to research that sought to better understand persuasive and effective LNT messaging. The TPB is designed to predict and explain human behaviors through measurement of three factors: attitudes, subjective norms, and perceived behavioral control (PBC). Attitude is the individual's global positive or negative evaluations of performing a particular behavior; subjective norms are the individual's perceptions of general social pressure to perform (or not to perform) the behavior; and PBC is perception of ease or difficulty to perform the behavior (Ajzen, 1991). Ajzen posits that these three factors influence a person's intention (how much effort they are willing to put towards performing a behavior), which may subsequently determine their behavioral achievement. These three factors are also influenced by the antecedents of behavioral beliefs, control beliefs, and norm beliefs (Ajzen, 1991). Behavioral beliefs are influenced by the attributes and likely consequences of the behavior, normative beliefs are influenced by the expectations of significant others, and control beliefs are influenced by the presence or absence of conditions that allow or block the achievement of the behavior. (Ajzen, 1991).

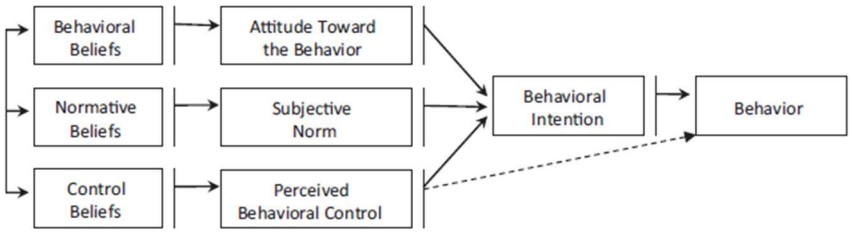

FIGURE 2 – Theory of Planned Behavior (Ajzen, 1991)

The TPB is based on the Theory of Reasoned Action (TRA). What differentiates the two theories is the TPB's addition of perceived behavioral control. Perceived behavioral control was added because it was thought to allow prediction of behaviors that were not under complete volitional control of the individual (Armitage & Connor, 2001). Perceived behavioral control has been described as a spectrum, with behaviors completely under the control of a person on one end and behaviors that are impossible to carry out on the other end (Connor & Armitage, 1998). According to the TPB, performance of a behavior is a joint function of intentions and perceived behavioral control. When the situation affords a person complete control over behavioral performance, intentions alone should be sufficient to predict behavior. However, perceived behavioral control as a predictor should become increasingly useful as volitional control over the behavior declines (Ajzen, 1991).

While the TPB is useful in designing studies for gathering data on visitor behavioral intentions, it is important to note limitations of the model. One notable instance is its limitation towards explaining variance of behavior. A meta-analysis by Sutton (1998) showed that TPB explains an average of 39% of the variance in behavioral intentions and 27% of the variance in behaviors. This leaves a significant amount of variation unexplained (Sutton, 1998). While Sutton provides reasonable arguments as to why statistical analysis of variance may not properly reflect practical application or success in behavioral sciences, improvements can be made to the TPB. Ajzen (1991) even states that the TPB is open to the inclusion of additional predictors if they can capture a significant portion of the variance in intention or behavior after the theory's three main factors have been taken into account. As such, the TPB is an important framework in behavioral sciences, yet offers flexibility for improvement, including and added predictors based on the individual goals of researchers.

Use of TPB in LNT Research

The TPB has been used as a theoretical framework in previous studies that attempted to better understand recreationists' behavioral intent towards LNT practices (Coulson et al., 2021; Lawhon et al., 2013, 2017; Vagias et al., 2014). In his dissertation, Vagias (2009) operationalized and empirically evaluated the TPB to investigate compliance with LNT principles and to find potential improvement for the delivery of LNT education. Due to the TPB's use in previous recreation and conservation research, Vagias theorized that if the three factors included in the TPB (attitudes, norms, and perceived behavioral control) can predict behavioral intent and if the factors can be influenced, land managers can use communication that is designed to influence visitors' behaviors towards practice of LNT principles (Vagias, 2009).

Vagias used the TPB as a framework to create the Leave No Trace Attitudinal Inventory and Measure (LNT AIM). The LNT AIM is an instrument that is intended to measure attitudes regarding specific practices addressed by the LNT principles (Vagias et al., 2012). The instrument was developed using widely accepted scale procedures (DeVellis, 2003) and received feedback during development via expert panel dialogue and cognitive interviews of participants from populations of interest. A Confirmatory Factor Analysis (CFA) was also used to test for consistency of model selection and item measurement. (Vagias et al., 2012). This allowed for the creation and analysis of an instrument believed to accurately assess visitors' backcountry ethics and attitudes towards LNT practices.

The LNT AIM has served as the foundational instrument used by multiple studies in multiple public land designations and with different visitor types including hikers, backpackers, campers, anglers, and mountain bikers in Wyoming State Parks (Lawhon et al., 2017), rock climbers in Shawnee National Forest (Coulson et al., 202), day hikers and backpackers in Rocky

Mountain National Park (Lawhon et al., 2013; Taff et al., 2014), and day hikers and backpackers in Olympic National Park (Taff et al., 2014). These studies adapted the LNT AIM instrument to gather data on variables that influence visitors' behavioral intent towards LNT principles. The five variables common to these studies are: 1) attitudes towards LNT, 2) perceived effectiveness of LNT practices, 3) perceived difficulty of practicing LNT, 4) self-reported knowledge of LNT, 5) behavioral intent of towards practicing LNT.

These variables were explored because they were found to be meaningful indicators of visitor behavioral intentions towards practicing LNT, and because education efforts that engage visitors with messaging may vary considerably depending upon the type of protected area and location (Lawhon et al., 2013, 2017; Vagias & Powell, 2010; Vagias et al., 2014).

Findings from some studies suggest that perceived effectiveness is the strongest predictor of LNT behavioral intent (Lawhon et al., 2013, 2017). Additionally, in some studies, respondents reported above average or expert knowledge of LNT principles. However, other questions in surveys indicated that there was a discrepancy between self-reported knowledge and understanding of, and behavioral intent towards, some LNT principles (Lawhon et al., 2017; Taff, et al., 2011, 2014). Findings generally indicated that self-reported knowledge was not a significant indicator of behavioral intent. This suggests that land managers should focus educational programs on effectiveness of LNT at reducing impact.

The aforementioned studies were predominantly conducted in the western United States. This lack of data in the eastern United States reveals a gap in knowledge that should be filled in order to improve LNT educational efforts by eastern land managers. While studies from other geographic locations can be used to guide LNT messaging in the eastern United States, it would likely be more effective to study visitors on public lands such as GRSM to better inform

educational strategies and specific messages. Therefore, exploring hikers' behavioral intentions towards LNT in GRSM will help further the LNT organization, and the NPS, in crafting and deploying effective LNT messaging and education in eastern protected areas.

Critiques of Leave No Trace

Despite, or likely because of, LNT's broad popularity in the outdoor industry, there are notable critiques that should be addressed and understood. Authors specify three main limitations of the Principles and of the LNT educational model. They include the displaced carbon footprint due to the consumption of outdoor gear, a lack of acknowledgement of LNT outside the boundaries of public lands, and a perceived separation of humans from nature (Alagona & Simon, 2009, 2012; Beery, 2014; Loynes, 2018).

Critics state that LNT's curriculum may encourage a change in individual behavior in outdoor spaces without addressing greater societal impacts that contribute to climate change. For example, Loynes (2018) states that LNT ethics do not encourage visitors to consider the carbon footprint of driving their vehicle a long distance to a trailhead. Other examples include lack of consideration for the carbon footprint created by new outdoor gear. More specifically, Alagona & Simon (2012) state that gear does not reduce environmental impacts. Rather it only displaces them from the sites of consumption to sites of production, distribution, and disposal. Additionally, authors argue that in its attempt to reduce impact on public lands, LNT perpetuates the view of humans as separate from nature. They suggest that this view of humans as separate rather than of nature limits educators' ability to help students connect with nature and is harmful to the overall goal of teaching them to maintain the health of public lands. (Beery, 2014; Loynes, 2018).

Further, some authors state that it would be beneficial for the LNT organization to encourage ways for the public to "leave more trace" (Loynes, 2018). In other words, the LNT organization should acknowledge the ways that land managers actively manage public lands to maintain their health and integrity. They argue that not making this aspect more visible to the public stymies their understanding of LNT and further separates humans from nature. The authors argue that it is our responsibility to recognize when it is appropriate to "leave no trace" and when it is appropriate to manage the landscape in a visible and widespread way.

While the present study used a quantitative survey that may avoid potential positive researcher bias towards LNT, it is necessary to outline critiques of overall LNT curriculum. Awareness of these concerns will inform any potential positive bias researchers may have towards LNT. It is important to state that the LNT organization, along with academic researchers, have noted and formally rebutted some arguments made in the previously mentioned articles, and clarified the specific mission of the LNT organization. Additionally, they are aware of and actively working on relevant opportunities for refinement within the LNT curriculum. (Marion et al., 2011).

CHAPTER 3: METHOD

Method

Survey Design

This study was conducted in collaboration with the Leave No Trace organization and was informed by the theoretical framework of the TPB to explore the relation between visitors' views of LNT and their behavioral intent. A questionnaire was shared by the LNT organization that was derived from Vagias' LNT AIM instrument. It has been validated and used in multiple LNT studies in different public lands and with different visitor types in Wyoming State Parks (Lawhon et al., 2017), Shawnee National Forest (Coulson et al., 2021), Rocky Mountain National Park (Lawhon et al., 2013; Taff et al., 2014), and Olympic National Park (Taff et al., 2014). The questionnaire was used in these studies because it allowed researchers to effectively gather data on attitudes, perceptions, and behavioral intentions towards LNT from a large number of visitors who engage in different types of outdoor recreation activities (Vagias et al., 2012). Understanding of these variables can help land managers and educators generalize findings towards a greater population of visitors and develop more refined and targeted educational LNT programs (Coulson et al., 2021). Please see the GRSM Visitor Survey in Appendix B.

In addition to the LNT AIM instrument created by Vagias, further studies have used the TPB to determine variables that influence visitors' behavioral intent towards LNT practices (Lawhon et al., 2013, 2017; Taff et al., 2012; Vagias et al., 2014). Therefore, this study was founded in the theoretical framework of TPB to explore the relation between variables related to visitor views of LNT and their influence on visitors' behavioral intent.

Instrument

The GRSM Visitor Survey included a quantitative instrument that used a seven-point Likert-type scales to pose questions based on the Seven LNT Principles. It was adapted from the LNT AIM instrument (Vagias et al., 2012). The LNT AIM instrument was created using outlines from a scale development resource (DeVellis, 2003) and was refined through feedback from experienced outdoor educators, as well as cognitive interviews of participants (Vagias et al., 2012). The overall factor structure was then analyzed using a confirmatory factor analysis (CFA) to further explore how each of the individual items loaded onto the 5 theoretical factors and included estimates of goodness-of-fit for the proposed model (Vagias et al., 2012). Vagias et al., (2014) reported the reliability of the scale in two different samples. The Cronbach's alpha ranged from $\alpha = .27 - .84$, with the majority of the reliability estimates falling within acceptable benchmarks for exploratory research ($\alpha \geq .5$) (Vagias et al., 2014). Reliability estimates for the subscale "Dispose of Waste Properly" (Vagias et al., 2014) were unacceptable for both the Olympic ($\alpha = .34$) and Glacier ($\alpha = .27$) National Parks samples, indicating that the items in this subscale do not consistently measure the same underlying factor. In other words, any findings based on this subscale should be interpreted with great caution. Low α-scores would typically lead a researcher to remove the unreliable factor from subsequent analyses, but it was determined that the wide variety of LNT practices, especially in the "Dispose of Waste Properly" category made it unlikely and undesirable that the set of items would correlate (Vagias et al., 2014). The authors believed that the lower α-scores on this subscale may be advantageous towards attempts to cover the scope of each LNT principal. As such, the items were not removed from the instrument. Regardless, awareness of unreliable subscales was vital in analysis of data for this study, as affected the strength of subsequent interpretations of findings.

The instrument has since been adapted and used in similar studies (Coulson et al., 2021; Lawhon et al., 2013, 2017; Vagias et al., 2014) to gather data from visitors on five variables related to the LNT principles. They were: 1) attitudes towards LNT, 2) perceived effectiveness of LNT practices, 3) perceived difficulty of practicing LNT, 4) self-reported knowledge of LNT, 5) behavioral intent of towards practicing LNT. The purpose of gathering data on these five variables was to determine which of the first four has the most influence on visitors' behavioral intentions towards LNT. Previous studies have shown that those variables are accurate predictors of whether visitors will engage in LNT practices (Coulson et al., 2021; Lawhon et al., 2013; 2017). If influences towards Leave No Trace behavioral intentions can be determined in GRSM, Park managers may be able to craft more effective messages for visitors regarding minimizing their recreation-related impacts.

Sites and Access

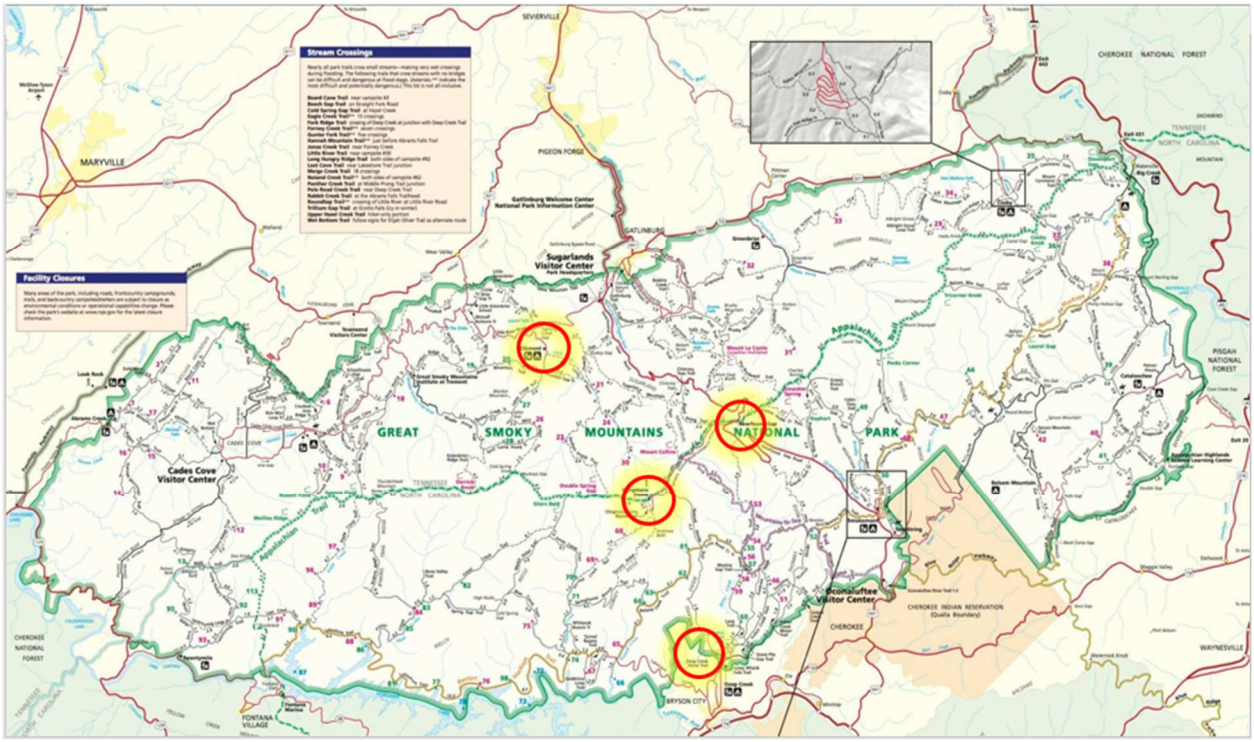

FIGURE 3 – GRSM Site Locations

Specific sites include trailheads for Newfound Gap, Alum Cave, Deep Creek, and Elkmont. Sites were chosen due to their popularity, ease of access by both hikers and researchers, wide geographic spread in the Park, and advice of GRSM Staff.

Sites were accessed starting November 1st and ending December 5th. Just over 300 participants (n=302) consented to take the questionnaire, and 285 participants fully completed their questionnaires for an overall response rate of 73%. This sample size was similar to studies conducted in Wyoming State Parks (Lawhon et al., 2017), Shawnee National Forest (Coulson et al., 2021), Rocky Mountain National Park (Lawhon et al., 2013; Taff et al., 2011; Taff et al., 2014), and Olympic National Park (Taff et al., 2014). Additionally, this sample size was appropriate for research within parks to achieve a high confidence level for generalizing to a population (Vaske, 2019). Two-thirds of site visits occurred on weekends, while one-third

occurred be on weekdays. Oversampling on weekends allowed for engagement with a larger number of hikers and reflect trends of visitor types to GRSM. Questionnaires were collected at one site per day due to time constraints of travel between sites during times of high visitor use.

Population and Sample

The population for this study was hikers on-site within the GRSM. Only adults 18 and older were asked to take the questionnaire. Hikers were approached and asked if they would like to take part in a questionnaire on visitor attitudes and perceptions about educational efforts in the Great Smoky Mountains National Park (please refer to Appendix B for the introductory script).

Visitors were approached through a stratified random sampling procedure (Vaske, 2019) to prevent researcher selection bias. Please see Appendix F for the sampling schedule. Frequency of approach was dependent on the visitation levels at specific trailheads. At Deep Creek and Elkmont, every second group was approached. At Newfound Gap and Alum Cave, every third group was approached due to the higher visitation rates at those trailheads.

The primary researcher read the script informing the visitor of the study, while simultaneously requesting their consent to participate. If the visitor confirmed, then the researcher handed them a paper copy of the questionnaire. Upon completion, the questionnaire was taken from the participant and then stored for later data entry. If any items remained incomplete, the participant was asked to fill them out accordingly. To reduce possibility of COVID-19 transmission, pens and clipboard were cleaned after each use with sanitary wipes. Additionally, the primary researcher wore a mask when social distancing of six feet or greater was not possible. This most commonly occurred when handing questionnaires to participants, or when visitors needed clarification on items in the questionnaire.

If a group was approached and multiple people provide consent, then whoever had the most recent birthday was asked to participate. If visitors decline to participate, a non-response bias question of "What's the primary purpose of your visit today?" was asked. This question was intended to capture a profile of the types of visitors who declined the survey to see what populations may have been underrepresented in the sample. Additionally, the primary researcher kept a survey log to record information such as time, date, location, weather, and other details that would not be found in the survey itself. Please refer to Appendix F for the survey log.

Ethical Considerations

This study received exempt status by the Western Carolina University (WCU) Institutional Review Board (IRB) due to the lack of foreseeable risk to study participants. While this study engaged with the public, the questionnaire did not ask for personally identifiable information beyond sex and zip code. No vulnerable populations such as minors or individuals with obvious mental impairment were asked to participate. In addition to IRB approval, a research permit was granted by GRSM research staff. While similar to an IRB, the research permit is specific to the National Park Service and is required for any research to be conducted in GRSM. Please refer to Appendix D for the GRSM research permit.

Lastly, no questionnaires were conducted in the backcountry due to the additional requirement of a Wilderness Analysis. A Wilderness Analysis is meant to explore the wilderness characteristic of certain sites within GRSM to ensure that research is not detrimental to the intended primitive experience of sites in the Park. Instead, data collection only took place at trailheads and only hikers who were entering trail systems were asked to participate. This was due to LNT signage that exists on the trail system that may have influenced participants' answers. While this limited the amount of backpackers that could be surveyed, it was a necessary

concession to gain research approval and to ensure that visitors were able to have an uninterrupted wilderness experience.

Data Analyses

All data was analyzed using SPSS statistics software. The independent variables were attitudes towards LNT, perceived effectiveness of LNT, perceived difficulty of LNT practices, and self-reported knowledge of LNT. The dependent variable was behavioral intent towards LNT practices. This was similar to analyses conducted in studies that used this instrument (Coulson et al., 2021; Lawhon, et al., 2013, 2017). Analyses were used to better understand the relationship between the four independent variables and the dependent variable (behavioral intent). Cronbach's alpha (α) was reported for each subscale as a measure of internal reliability. Measuring internal reliability helped ensure that there is consistency of results across items in the GRSM Visitor Questionnaire (Vaske, 2019).

Seven linear regression models were estimated, one for each behavioral intent item as they related to the Seven Leave No Trace Principles, to analyze the unique contributions of the independent variables on behavioral intent. The multiple regression models were: $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$; where the outcome Y_1 represented the specific behavioral intent item being assessed; the intercept B_0 represented the mean value of Y_1 when all predictor variables are equal to zero; B_1 represented the change in Y for every 1 unit of change in X_1 (attitude); B_2 represented the change in Y for every 1 unit of change in X_2 (perceived effectiveness); B_3 represented the change in Y for every 1 unit of change in X_3 (perceived difficulty); and B_4 represented the change in Y for every 1 unit of change in X_4 (self-reported knowledge). Additionally, to assess the percent of variance explained by each model, R^2 was reported for all 7 multiple regressions. R^2 is the statistical measure of the amount of variance that is being

explained in the dependent variable by the specified independent variables. Regression models were the most appropriate statistical technique to use here because the guiding research question asked about the linear, predictive relationship of the four independent variables on the dependent variable (Cohen & Cohen, 1983). The output of these multiple regression models helped directly answer this question. Once data analyses were completed, summary tables were created (see Table 1-6). Tables provide means, standard deviation, and percentages for each variable to show range of scores. Additionally, R^2 is provided (see Table 2) to show the overall percent of variance being explained by the model. R^2 shows the influence that the four variables have on behavioral intent towards LNT.

The following section is the manuscript for the selected Journal of Outdoor Education, Recreation, and Leadership. This is in lieu of chapters four and five of the thesis document. The URL to submission guidelines can be found below using this link https://js.sagamorepub.com/jorel/about/submissions. This manuscript is intended to be a regular paper. Manuscript length is generally 20-30 double-spaced pages (6,000-9,000 words) including all references, tables, and figure

Chapter 4 & 5: JOREL Journal Manuscript

Understanding Hikers' Behavioral Intent Towards Leave No Trace in Great Smoky Mountains National Park

Abstract

Resource degradation is a chief concern related to increased recreational of U.S. public lands. The Seven Leave No Trace (LNT) Principles are used to educate visitors how to reduce recreational impacts. This study sought to understand Great Smoky Mountains National Park (GRSM) hikers' behavioral intent towards LNT practices. A quantitative questionnaire was used to measure participants' behavioral intent towards LNT based on 4 predictor variables: attitudes of appropriateness, perceived effectiveness, perceived difficulty, and self-reported knowledge. 285 total questionnaires were completed. These results indicate that the predictor variables had varying levels of influence on hikers' behavioral intent, with perceived effectiveness and difficulty being the most significant predictors. GRSM staff may be able to reduce hiker impact by focusing education on the effectiveness and ease of practice of LNT Principles. GRSM staff may also provide education that increases hikers' understanding of impacts and emphasizes appropriateness of proper LNT behavior.

Keywords: Great Smoky Mountains National Park, leave no trace, theory of planned behavior, hikers

Understanding Hikers' Behavioral Intent Towards Leave No Trace in Great Smoky Mountains National Park

The Great Smoky Mountains National Park (GRSM) is situated within a day's drive of one-half the population of the United States and was visited more than 14.1 million times in 2020 (Visitor Experience Stewardship, 2022). This is a 57% increase in annual visitation rates since 2012 and makes it by far the most visited National Park in the entire United States (Visitor Experience Stewardship, 2022). Resource degradation is a primary concern related to the documented increase in visitor use of public lands. This can manifest in vegetation loss, soil compaction and erosion, degradation of water quality, and wildlife disturbance. (Arrendondo et al., 2021; Marion et al., 2016).

Most land managers have the dual mandates to conserve and protect public lands while promoting access to the public (Marion & Reid, 2001). They achieve this through two main strategies: direct and indirect management. Direct management strategies enforce regulations and may restrict access, but generally limits visitor autonomy and can create conflict (Dawson & Hendee, 2009). Indirect management emphasizes influencing behavior through more "light-handed" methods such as education and persuasive messaging (Dawson & Hendee, 2009; Hammitt et al., 2015). The use of indirect management focuses on expanding visitor awareness of impacts and encourages visitors to learn and apply low-impact skills and ethics dun). Leave No Trace (LNT) messaging is an important part of indirect management and is widely utilized by agencies and organizations across many land designations and geographic locations (Marion, 2014).

Leave No Trace

The Seven Leave No Trace (LNT) Principles (Figure 1) are prominent and widely used educational messages for environmentally responsible outdoor recreation in the U.S. and abroad (Lawhon et al., 2017; Taff et al., 2014). The Seven Principles are designed to educate visitors about potential environmental impacts of recreation and teach them skills and techniques to reduce these impacts.

The formation of the LNT curriculum came from a need to educate visitors on low-impact practices in the backcountry. Use of public lands in the U.S. began increasing in the 1960s due to the rising popularity of outdoor activities such as hiking, backpacking, and camping. This trend continued into the 1970s and 1980s, causing increased impact to the natural environments that visitors frequented. These impacts necessitated the creation of educational programs that would become the precursor to modern Leave No Trace education. Efforts of the USDA Forest Service (USFS), Bureau of Land Management (BLM) and National Park Service (NPS) in the late 1970s and early 80s eventually coalesced into a more standardized version of "No Trace" curriculum. In 1990, the USFS partnered with NOLS to develop a written LNT curriculum with the intention of creating a national program Shortly after, the program was formally adopted by the BLM, NPS, and U.S. Fish and Wildlife Service (USFWS) (Leave No Trace, 2021a; Marion & Reid, 2001).

Leave No Trace Principles:

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

Figure 1 - The Seven Leave No Trace Principles (Leave No Trace organization, 2021b)

In 1994, the non-profit Leave No Trace, Inc (now known as the Leave No Trace organization) was created to oversee research, funding, and projects related to LNT (Marion & Reid, 2001). The Leave No Trace organization is responsible for developing and expanding LNT

training and educational resources. In addition to its continued partnerships with federal land agencies, the LNT organization entered a Memorandum of Understanding (MOU) with America's State Parks in 2009, representing over 8,000 state parks. The LNT program has also been adopted internationally. These partnerships will continue to strengthen the LNT organization's efforts to expand LNT curriculum and provide greater opportunity for consistent educational messaging to all types of outdoor recreationists (Lawhon et al., 2017; Vagias & Powell, 2010).

Visitor Views of Leave No Trace

Historically, land managers have primarily promoted LNT messaging to backcountry users. However, due to the steady increase of public land use by frontcountry users, including day-hikers, there has been a push over the past 15 years to provide LNT messaging for these demographics (Marion, 2014). As such, there has been an increase in LNT research on frontcountry visitors to public lands. Multiple studies have been conducted on visitors' attitudes, perceptions, and behavioral intent towards LNT Principles as they pertain to outdoor recreation (Coulson et al., 2021; Lawhon et al., 2013, 2017, 2019; Taff et al., 2011, 2014). Understanding of these variables can help educators and land managers ensure their LNT educational messages are effective. (Lawhon et al., 2017; Taff, et al., 2014). Additionally, such research helps discern differences in intentions between different types of recreationists such as day-hikers versus backpackers (Taff et al., 2014).

The preponderance of LNT-focused research to date has been conducted in the western U.S. While studies from other geographic locations can be used to guide LNT messaging in the eastern United States, it is beneficial for studies to be completed in different areas such as GRSM to capture data on visitor perceptions, attitudes, behavioral intentions, and self-reported practice

of LNT (Lawhon, et al., 2017; Taff, et al., 2014). Prior to this study, no research had been conducted on visitor attitudes and behavioral intentions towards LNT in GRSM. Addressing the lack of LNT-specific research is especially important given GRSM's high visitation rates. Considering GRSM's popularity and proximity to a large density of the United States' population, this study on visitor attitudes, perceived difficulty of LNT, perceived effectiveness of LNT, self-reported knowledge, and behavioral intent towards LNT will assist Park staff in their understanding of visitor behavioral intentions, and implementation of LNT educational strategies. If influences towards Leave No Trace behavioral intentions can be determined in GRSM, Park managers may be able to craft more effective messages for visitors regarding minimizing their recreation-related impacts.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is fundamental to contemporary research that seeks to better understand persuasive and effective LNT messaging. The TPB (Figure 2) is designed to predict and explain human behaviors through measurement of three factors: attitudes, subjective norms, and perceived behavioral control (PBC). Attitude is the individual's positive or negative evaluations of performing a particular behavior; subjective norms are perceptions of general social pressure to perform (or not to perform) the behavior; and PBC is perception of ease or difficulty to perform the behavior (Ajzen, 1991). The TPB posits that these three factors influence a person's intention (how much effort they are willing to put towards performing a behavior), which may subsequently determine their behavioral achievement. These three factors are also influenced by the antecedents of behavioral beliefs, control beliefs, and norm beliefs (Ajzen, 1991). Behavioral beliefs are influenced by the attributes and likely consequences of the behavior, normative beliefs are influenced by the expectations of significant

others, and control beliefs are influenced by the presence or absence of conditions that allow or block the achievement of the behavior (Ajzen, 1991).

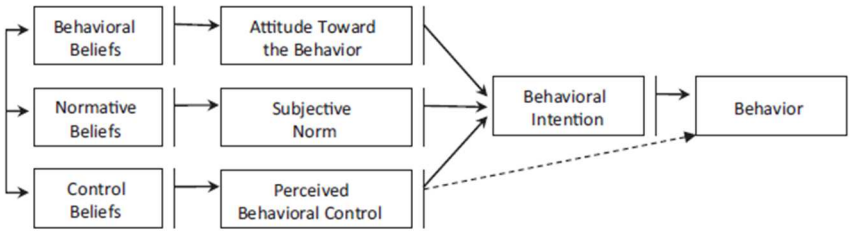

Figure 2- Theory of Planned Behavior (Ajzen, 1991)

Use of TPB in LNT Research

The TPB has been used as a theoretical framework in previous studies that attempt to better understand recreationists' behavioral intent towards LNT practices (Coulson et al., 2021; Lawhon et al., 2013, 2017; Vagias et al., 2014). Vagias (2009) operationalized and empirically evaluated the TPB to investigate compliance with LNT Principles, and to find potential improvement for delivery of LNT education. Due to the TPB's use in previous recreation and conservation research, Vagias theorized that if the three factors included in the TPB (attitudes, norms, and perceived behavioral control) can predict behavioral intent and if the factors can be influenced, land managers can use communication that is designed to orient visitors' behaviors towards practice of LNT Principles (Vagias, 2009).

Vagias used the TPB as a framework to create the Leave No Trace Attitudinal Inventory and Measure (LNT AIM). The LNT AIM is an instrument intended to measure attitudes regarding specific practices addressed by the LNT Principles (Vagias et al., 2012). It was developed using widely accepted scale procedures (DeVellis, 2003) and received feedback during development via expert panel dialogue and cognitive interviews of participants from populations of interest. A Confirmatory Factor Analysis (CFA) was also used to test for

consistency of model selection and item measurement (Vagias et al., 2012). This allowed for the creation and analysis of an instrument believed to accurately assess visitors' backcountry ethics and attitudes towards LNT practices.

The LNT AIM has served as the foundational instrument used by multiple studies in different public lands and with different visitor types including hikers, backpackers, fishers, and mountain bikers in Wyoming State Parks (Lawhon et al., 2017), rock climbers in Shawnee National Forest (Coulson et al., 2021), day-hikers and backpackers in Rocky Mountain National Park (Lawhon et al., 2013; Taff et al., 2014), and day-hikers and backpackers in Olympic National Park (Taff et al., 2014). These studies adapted the LNT AIM instrument to gather data on variables that influence visitors' behavioral intent towards LNT Principles. The five variables common to these studies are: 1) attitudes towards LNT, 2) perceived effectiveness of LNT practices, 3) perceived difficulty of practicing LNT, 4) self-reported knowledge of LNT, 5) behavioral intent of towards practicing LNT. These variables are explored because they were found to be meaningful indicators of visitor behavioral intentions towards practicing LNT (Lawhon et al., 2013, 2017; Vagias & Powell, 2010; Vagias et al., 2014).

Findings from some studies suggest that perceived effectiveness is the strongest predictor of LNT behavioral intent (Lawhon et al., 2013, 2017). Additionally, respondents in previous studies reported above average or expert knowledge of LNT Principles. However, other questions in surveys indicated that there was a discrepancy between self-reported knowledge and behavioral intent towards some LNT Principles (Lawhon et al., 2017; Taff, et al., 2011, 2014). Previous findings indicated that self-reported knowledge was not a significant indicator of behavioral intent (Coulson et al., 2021; Lawhon et al., 2017). This suggests that land managers should focus educational programs on effectiveness of LNT at reducing impact. Therefore, the

purpose of this study was to explore hikers' behavioral intentions towards LNT Principles in GRSM. This study replicated past LNT research to provide important information for parks in the eastern United States and to inform educational efforts by GRSM staff and the Leave No Trace organization, the non-profit organization that manages LNT efforts in the U.S. and abroad.

Methods

This study was informed by the theoretical framework of the TPB to explore the relation between visitors' views of LNT and their behavioral intent. The GRSM Visitor Questionnaire was adapted from the LNT AIM instrument and used a seven-point Likert-type scale to assess the Seven LNT Principles. The items in the questionnaire were drawn from previous peer-reviewed studies designed to improve understanding of LNT behavioral intent (Coulson et al., 2021; Lawhon et al., 2013, 2017; Taff et al., 2011, 2014; Vagias et al. 2012, 2014). The questionnaire explored five variables: 1) attitudes towards LNT, 2) perceived effectiveness of LNT practices, 3) perceived difficulty of practicing LNT, 4) self-reported knowledge of LNT, 5) behavioral intent of towards practicing LNT. The purpose of gathering data on these five variables was to determine which variable(s) (1-4) had the most influence on GRSM hikers' behavioral intentions towards LNT.

Data collection sites in GRSM included Newfound Gap, Alum Cave, Deep Creek, and Elkmont. Sites were chosen due to their visitation rates, wide geographic spread in the Park, and advice of GRSM staff. Trailheads were accessed over a four-week period between November and December 2021. Two-thirds of site visits occurred on weekends, while one-third occurred on weekdays. Oversampling on weekends allowed for engagement with a larger number of hikers and reflected trends of visitor types to GRSM.

Participants

Study participants' median birth year was 1974 (48% male, 52% female). Nearly one third (27%) of participants indicated that this was their first visit to GRSM in the past twelve months. Forty-six percent indicated they had visited GRSM 1-2 times in the past twelve months. Over 26% indicated they had visited GRSM between 3-10 times in the past twelve months. Just over one fifth (21%) of participants were from North Carolina or Tennessee, while the remainder were from other states within the U.S. or from international countries.

The population was hikers 18 years and older on-site within GRSM. A total of 285 participants completed questionnaires with an overall response rate of 73%. Hikers were approached through a stratified random sampling procedure (Vaske, 2019). Only one group was approached at a time. If hikers decline to participate, a non-response bias question of "What's the primary purpose of your visit today?" was asked to capture a profile of the types of hikers who may have been underrepresented in the sample. The primary researcher informed the hiker of the study, while simultaneously requesting their consent to participate. If the hiker confirmed, then the researcher handed them a paper copy of the questionnaire to be filled out. To reduce possibility of COVID-19 transmission, pens and clipboard were cleaned after each use by participants using sanitary wipes. Additionally, the primary researcher wore a mask when social distancing of six feet or greater was not possible.

Results

Means and standard deviations for all variables fall within the expected ranges (Table 1), compared to previous samples (Coulson et al., 2021; Lawhon et al., 2017). Reliability estimates of the predictor variables were shown to be within acceptable range (Table 2). Cronbach's alpha was not estimated for knowledge because it consisted of a single item (Vaske, 2019).

Attitudes of Appropriateness toward LNT Practices

Participant responses to attitudes of appropriateness items are summarized in Table 3. Over a quarter of participants (28%) felt neutral towards *Scheduling my trip during times of high use to reduce overall impact*. While a greater number of participants felt it was appropriate to very appropriate (45%), this may indicate that visitors to GRSM find less significance in planning around popular times due to the high visitation rates of GRSM on a nearly year-round basis. Almost half of participants (47%) indicated that *Carrying all litter out, leaving only food scraps behind* was appropriate to very appropriate. This may mean that visitors either are unfamiliar with LNT recommendations of packing out food scraps, or that the question may have been misinterpreted by some participants. Additionally, a greater number of participants thought it was very appropriate (30%) to *Walk around muddy spots on the* trail, rather than very inappropriate (20%). This indicates that participants may be unaware of appropriate practices when traveling on trail. Lastly, 40% of respondents indicated that *Taking a break along the edge of the trail* was very appropriate, despite LNT's recommendation of moving away from trails for breaks so trail use is not restricted. Mean scores in all other categories were 3.88 or lower, indicating that visitors had a better understanding of these Principles and their associated recommendations.

Perceived Effectiveness of LNT Practices

Participant responses to perceived effectiveness items are summarized in Table 4. All appropriate practices were perceived to be effective often or every time ($M \geq 5.14$), indicating that participants understood the overall effectiveness of these behaviors, regardless of their attitudes, or perceived difficulty of practices. It is likely that if participants perceive proper LNT behaviors as effective at reducing impact, then they are more likely to practice them.

Perceived Difficulty of LNT Practices

Participant responses to perceived difficulty items are summarized in Table 5. All but one of the items received a mean score of 2.43 or lower, meaning that participants did not find these behaviors difficult to practice. The mean score on the item *Scheduling trip to avoid times of high use* was 3.13, which shows that while most visitors still perceived this as either not at all or somewhat difficult (59%), other participants (41%) perceived this as moderately or extremely difficult. Considering GRSM's high visitation rates, this perception of difficulty may have a relationship with the neutral attitude that some visitors have towards scheduling trips during times of high use as a means to reduce impact.

Self-reported Knowledge of LNT

Participant responses to the knowledge item are summarized in Table 6. Knowledge was measured using a single item on a seven-point scale ranging from No Knowledge to Expert. Two thirds (66%) of participants rated themselves as having Above Average, Extensive, or Expert levels of knowledge. One fifth (20%) rated themselves as having Average levels of knowledge. The remainder of 14% rated themselves as having Limited to No Knowledge.

Behavioral Intent Towards LNT Principles

Participant responses to behavioral intent items are summarized in Table 7. Respondents indicated that they were likely or extremely likely to perform all recommended behaviors except for the behavior *Taking breaks away from the trail and other visitors* (M = 4.36). While participants still indicated that they were moderately likely to take breaks away from the trail and other visitors, the findings show that GRSM hikers may be less likely to do so compared to the other measured behaviors.

Regression Analyses

The independent variables (IV) were attitudes towards LNT, perceived effectiveness of LNT, perceived difficulty of LNT practices, and self-reported knowledge of LNT. The dependent variable (DV) was behavioral intent towards LNT practices. Multiple Regression analyses were used to better understand the relationship between the four IV's and the DV. Specifically, seven linear regression models were estimated, one for each behavioral intent item.

Regression coefficients and R^2 estimates for the 7 regression models are presented in Table 8. Attitudes towards appropriate behavior significantly predicted "Not feeding, following, or approaching wildlife", $\beta = .25$, $p \leq .001$. Perceived effectiveness predicted 5 of the 7 behavioral intent items, ranging from $\beta = .30$, $p \leq .001$ to $\beta = .17$, $p \leq = .05$. Perceived difficulty significantly predicted "Preparing for all types of weather", $\beta = -.28$, $p \leq .001$; and "Staying on designated trails", $\beta = -.21$, $p \leq .001$. Lastly, knowledge predicted "Preparing for all types of weather", $\beta = .19$, $p \leq .001$; and "Staying on designated trails", $\beta = .14$, $p \leq .05$. R^2 calculations provide estimates of the amount of variance in the DV that was being explained by the IV's (Vaske, 2019). R^2 in these 7 models ranged between .18 and .03, indicating that only 3-18% of the variance of behavioral intent was explained by the 4 predictor variables in this sample. In other words, each of the four variables had varying degrees of influence on hikers' behavioral intent.

Attitude towards LNT was shown to be a strong predictor of hikers' intent for appropriate behavior towards wildlife. Within this sample, perceived effectiveness of LNT was shown to be a moderate to high predictor of hikers' intent towards five of the seven items: staying on designated trails, carrying out all litter, use of campfires, appropriate behavior towards wildlife, and proper etiquette when hiking with others. Additionally, perceived difficulty of LNT was

shown to be a strong predictor of hikers' intent towards preparing for hazards and staying on designated trail. Lastly, knowledge of LNT was shown to be a strong predictor of hikers' intent towards preparing for hazards and a moderate predictor for staying on designated trails.

None of the variables were shown to be predictors of the item *Not removing natural objects from the area*. While this is contrary to previous research that shows variables measured were predictors for this item (Coulson et al., 2021; Lawhon et al., 2017), it may indicate that GRSM hikers are not influenced by the variables for this behavior. As such, exploration of additional variables that affect behavioral intent is likely necessary.

Table 1
Descriptive Statistics for the LNT AIM

	N	Minimum	Maximum	Mean	Std. Deviation
Attitude	298	1.50	5.14	3.37	.63
Perceived Effectiveness	300	3.80	7.00	5.91	.74
Perceived Difficulty	294	1.00	6.00	1.93	.74
Knowledge	302	.00	6.00	3.81	1.44
Behavioral Intent Item 1	302	2.00	7.00	6.12	1.22
Behavioral Intent Item 2	300	1.00	7.00	6.13	1.27
Behavioral Intent Item 3	301	1.00	7.00	6.65	.97
Behavioral Intent Item 4	302	1.00	7.00	2.69	2.17
Behavioral Intent Item 5	300	1.00	7.00	5.58	1.83
Behavioral Intent Item 6	301	1.00	7.00	2.03	2.04
Behavioral Intent Item 7	301	1.00	7.00	4.36	1.96

Note: Behavioral intent items can be viewed in Table 6

Table 2
Reliability Estimates for Predictors of Behavioral Intent

Variable	α
Attitude	.61
Per Eff	.75
Per Diff	.81
Knowledge	---

Note: Knowledge consisted of a single item.

Table 3

Attitudes Towards Leave No Trace Practices

	N	Mean	SD	Percentage						
How APPROPRIATE or INNAPROPRIATE do you think the following activities are for a visitor to do in Great Smoky Mountains National Park				Very Inappropriate			Neutral			Very Appropriate
				1	2	3	4	5	6	7
Experiencing parks by not preparing for weather/hazards	302	1.88	1.29	55	23	9	7	2	2	1
Scheduling trips to avoid times of high use	302	3.7	1.81	11	7	10	28	15	16	14
Traveling off trail to experience the natural environment	302	2.83	1.90	34	21	12	12	9	5	7
Carrying out all litter, leaving only food scraps	300	4.17	2.54	27	10	8	8	4	8	35
Keeping a single item like a rock, plant, stick or feather as a souvenir	302	2.43	1.56	39	23	11	16	7	3	2
Having a small campfire in an existing fire ring	301	2.00	1.38	3	2	.3	9	8	31	47
Dropping food on the ground to provide wildlife a food source	302	1.33	.87	81	12	3	2	1	0	1
Taking a break along the edge of a trail	302	5.26	1.53	4	2	5	15	23	28	23

Table 4

Perceived Effectiveness of Leave No Trace Practices

	N	Mean	SD	Percentage						
Participating in the following activities in Great Smoky Mountains National Park would reduce impact…				Never			Sometimes		Every time	
				1	2	3	4	5	6	7
Preparing for all types of weather, hazards, and emergencies before getting on trail	302	6.25	1.1	1	0	1	10	10	22	58
Staying on designated or established trails	302	6.35	1.01	.3	0	2	5	8	24	61
Carrying out all litter, even crumbs, peels, or cores	302	6.65	.916	.3	1	1	2	4	11	81
Never removing objects from the area, not even a small item like a rock, plant, or stick	302	5.85	1.52	2	2	6	11	11	17	52
Having a small campfire in an existing fire ring	302	5.93	1.3	1	1	2	10	12	30	43
Never approaching, feeding, or following wildlife	302	6.21	1.61	4	3	2	3	4	13	71
Taking breaks away from the trail and other visitors	301	5.14	1.62	4	2	7	25	15	20	28

Table 5

Perceived Difficulty of Leave No Trace Practices

	N	Mean	SD	Percentage						
Please indicate how DIFFICULT you think each of the following would be for a visitor to do in Great Smoky Mountains National Park…				Not at all Difficult		Moderately Difficult			Extremely Difficult	
				1	2	3	4	5	6	7
Preparing for all types of weather, hazards, and emergencies before getting on trail	302	2.43	1.51	37	22	17	13	6	3	1
Scheduling trips to avoid times of high use	302	3.13	1.7	22	17	20	21	10	7	3
Staying on designated or established trails	298	1.66	1.1	59	25	8	4	1	1	1
Carrying out all litter, even crumbs, peels, or cores	302	1.33	.87	81	12	3	2	1	.3	1
Never removing objects from the area, not even a small item like a rock, plant, or stick	301	1.48	.94	72	16	6	4	1	0	.3
Having a small campfire in an existing fire ring	302	1.69	1.08	62	20	9	8	1	1	0
Never approaching, feeding, or following wildlife	302	1.28	.8	85	8	3	2.3	2	0	0
Taking breaks away from the trail and other visitors	301	1.90	1.17	51	23	16	6	2	1	0

Table 6

Level of Self-described Leave No Trace Knowledge

N	Mean	SD	Percentage						
			No Knowledge	Very Limited	Limited	Average	Above Average	Extensive	Expert
			0	1	2	3	4	5	6
302	3.81	1.44	4	5	5	20	35	20	11

Table 7

Behavioral intentions to practice Leave No Trace in the future

	N	Mean	SD	Percentage						
Please indicate how LIKELY you are to do the following activity in the future…				Not at all Likely			Moderately Likely			Extremely Likely
				1	2	3	4	5	6	7
Preparing for all types of weather, hazards, and emergencies before getting on trail	302	6.12	1.22	0	1	2	13	11	16	58
Staying on designated or established trails	300	6.13	1.3	1	1	4	7	11	19	57
Carrying out all litter, even crumbs, peels, or cores	301	6.65	.97	1	1	1	1	2	13	81
Removing objects from the area, not even a small item like a rock, plant, or stick	302	2.69	2.2	52	10	7	6	8	7	10
Having a small campfire in an existing fire ring	300	5.58	1.83	7	1	4	15	10	14	50
Approaching, feeding, or following wildlife	301	2.03	2.03	73	7	3	3	1	2	12
Taking breaks away from the trail and other visitors	301	4.36	1.9	13	7	8	25	15	13	19

Table 8
Regression Coefficients and R^2 Estimates Predicting Leave No Trace Behavioral Intent

Behavioral Intent	Attitude	Perc Eff	Perc Diff	Knowledge	R^2
1. Preparing for all types of weather, hazards, and emergencies	-.07	.09	-.28**	.19**	.18
2. Staying on designated or established trails	-.07	.17*	-.21**	.14*	.16
3. Carry out all litter, including food scraps	-.06	.17*	-.11	-.03	.06
4. Not removing natural objects from the area	.11	-.06	.00	-.05	.03
5. Having a small campfire in an existing fire ring	-.14	.23*	.10	.08	.09
6. Not feeding, following, or approaching wildlife	.25**	.19*	.03	.05	.05
7. Taking breaks away from trails and other visitors	.07	.30**	-.07	.00	.09

Note: * $p \leq .05$, ** $p \leq .001$

Discussion and Recommendations

Within this data, attitudes of appropriateness had the greatest range in participants' answers regarding recommended LNT practices. This indicates that while participants generally found LNT practices to be effective and easy to practice, there was less uniformity on their perception of appropriateness when recreating. More specifically, some participants appeared to not understand or agree with the appropriateness of items that measured behaviors for LNT Principles *Travel and Camp on Durable Surfaces, Dispose of Waste Properly*, and *Be Considerate of Other Visitors*. This could be due to a lack of understanding of LNT Principles, a lack of agreement with recommended guidelines, or because of confusing wording of some items. Respectively, these principles recommend that visitors travel through muddy spots to avoid causing additional erosion on the edges of the trail, packing out all food scraps, and take breaks away from trails and other visitors as long as durable surfaces are accessible. These results indicate that GRSM staff could potentially increase visitor knowledge and possibly reduce negative impact by providing education that clarifies these three principles. Considering

that the reasoning for these behaviors may not be intuitively apparent to novice hikers, there could be noticeable benefit on the trail environment with appropriate outreach.

Similar to previous research (Coulson et al., 2021; Lawhon et al., 2013, 2017), the participants in the present study found LNT practices effective and not difficult to practice, regardless of their attitudes. The lone exception was the perceived difficulty of *Scheduling trip to avoid times of high use*, which aligns with *Principle 1: Plan Ahead and Prepare.* The possible implications of this are that GRSM hikers believe planning trips around popular times is a potentially difficult affair, regardless of whether they believe it will reduce impact. This is likely a result of GRSM's record-breaking visitor rates. GRSM staff may reduce the perceived difficulty of this behavior by highlighting less popular trails or cautioning hikers to make alternative plans when popular trails will be especially busy. Further exploration into other reasons hikers find avoiding popular times difficult can help explore other variables that influence their beliefs.

The majority of participants rated themselves as having an above average or higher levels of LNT knowledge (Table 6). This is consistent with previous research that measured participants' self-reported knowledge of LNT (Coulson et al., 2021; Lawhon et al., 2013, 2017; Taff et al., 2014). Results regarding attitudes show that there are discrepancies between participants' self-reported knowledge and recommended LNT practices. This suggests that some participants may have incorrectly assessed their understanding of LNT or are unfamiliar with appropriate practices associated with certain LNT Principles.

Consistent with previous research, perceived effectiveness and perceived difficulty were found to have the most influence on GRSM hikers' behavioral intent towards LNT. (Coulson et al., 2021; Lawhon et al., 2013, 2017). Similarly, attitudes towards appropriateness were found to

be a good predictor of intent. However, unlike previous research, knowledge was found to be a more meaningful predictor for GRSM hikers (Coulson et al., 2021; Lawhon et al., 2013, 2017). Therefore, GRSM hikers may have differences in understanding and motivations toward LNT than recreational users from other public lands. The only item not influenced by any of the variables was *Not removing natural objects from the area*, which aligns with *Principle 4: Leave What You Find*. This is contrary to results that show GRSM participants generally believed not removing natural objects was appropriate, easy to practice, and effective at reducing impact. Despite this, the four IV's may still be useful points of persuasion for educating GRSM hikers on best practices for Principle 4. However, this demonstrates that either participants misunderstood what the questions of behavioral intent were trying to ask, or they are influenced by other variables not measured by this questionnaire. Based on these findings, GRSM Park staff could improve visitor education by focusing on the effectiveness and ease of practice of LNT Principles. Furthermore, park staff can provide education that increases visitor understanding of impacts and emphasizes appropriateness of proper LNT behavior.

Limitations

There are three notable limitations present in this study: 1) generally low R^2 values, 2) potentially ambiguous items, and 3) assessment of participants' self-reported LNT knowledge. These limitations, among others, have also been noted in previous studies (Coulson et al., 2021; Lawhon et al., 2013, 2017; Taff et al., 2014; Vagias et al., 2014). Future researchers would benefit from not only exploring the limitations in this study, but from previous literature as well.

. First, while the four variables of attitudes, perceived effectiveness, perceived difficulty, and self-reported knowledge may be generally good predictors of LNT behavioral intent, the R^2 for these models showed that between 82% and 97% of the variance present in behavioral intent

is yet to be explained. In other words, there are likely other variables that contribute to behavioral intent beyond the four variables that were measured in this instrument. Thus, the evaluation and potential incorporation of other predictor variables such as emotions (Lawhorn et al., 2017) connection to nature, or greater environmental beliefs may be beneficial.

Second, some items may have been misinterpreted by participants due to ambiguous wording. For example, while 55% of participants correctly indicated that the item *Experiencing parks and historic sites by not preparing for all types of weather or hazards before I get on a trail* was inappropriate, some participants needed clarification on the intended direction of their answer. The negated phrasing of "not preparing" may need to be evaluated for clarity in future applications of the questionnaire. Similarly, some participants may have been confused by item 1b *Scheduling my trip during times of high use to reduce overall impact*. Some participants needed clarification on whether the item was asking if they think it is appropriate to hike on trails during popular times or plan their trip to avoid popular times. Item 1f *Carrying out all litter, leaving only food scraps* confused some participants, as it may be unclear which behavior, carrying out all litter or leaving food scraps behind, was inappropriate.

Third, assessment of LNT knowledge is limited to one item within the LNT AIM. Namely, this item asks participants to provide their self-reported knowledge of LNT practices, rather than testing their knowledge with a set of questions. Measuring self-reported knowledge through a single item limits its usefulness as a predictor of behavioral intent. Instead of measuring self-reported knowledge, the inclusion of additional items that test participants' actual knowledge of LNT may create more robust measures of knowledge and therefore improve its efficacy in predicting intent.

Management Implications

Park staff may use this improved understanding of GRSM hikers' behavioral intent towards LNT to create specific messages for each of the Seven Principles that target these variables. For example, since perceived difficulty and knowledge were found to be highly significant for the item *Preparing for all types of weather, hazards, and emergencies* (i.e., Principle 1 of LNT: Plan Ahead and Prepare), Park staff may want to frame educational language for planning ahead and preparing in a way that prioritizes gaining knowledge prior to starting the trip and emphasizes ease of gaining relevant knowledge beforehand. This could lead to better practice of LNT by hikers in the park, minimizing recreation-related impacts in GRSM, and potentially improving visitor experience.

This study intended to capture views from both day-hikers and backpackers, however, participants were almost exclusively day-hikers. Therefore, backpackers' views of LNT Principles are limited to an extremely small sample ($n=16$) and findings are unable to be generalized to a greater population for backpackers. While this study could not determine if there are notable differences between day-hikers and backpackers in their LNT behavioral intent, previous research shows that the two groups likely have similarities in their views and intent towards LNT practices (Taff et al., 2014). This may indicate that backpackers in GRSM can be influenced by similar messaging as day-hikers. However, further research specifically into GRSM backpacker populations would make it more apparent if results from this study can be catered towards backpackers in addition to day-hikers. Additionally, GRSM visitors vary widely in their recreation activities, including horseback riding, fishing, whitewater sports, and cycling. While day-hikers and backpackers have overlap in their recreational pursuits, the wide variety of behaviors and motivations of other visitor types make it difficult to determine if the findings

from these studies may be useful for creating educational messaging beyond hikers. This is especially true given that items measured in the questionnaire were specifically oriented to hikers. As such, GRSM staff should be cautious in using these findings to craft LNT messaging for other visitor types.

As previously discussed, a sizeable portion of GRSM hikers found it difficult to plan their trips around times of high use and felt neutral about its appropriateness. Considering this, expansion of programs that mitigate negative experiences due to overcrowding could be beneficial to GRSM hikers. The Laurel Falls Trail 2021 Congestion Management Pilot provides a template for possible expansion into other trailheads. The program prohibited roadside parking by use of physical barriers and staff presence, implemented timed-entry parking reservations to allow for better trip planning by visitors, and provided shuttle services for hikers. Alum Cave Trailhead, for example, can experience roadside parking and on-trail overcrowding in a similar manner as Laurel Falls. GRSM Park staff may consider a pilot program at trailheads such as Alum Cave if findings from the Laurel Falls Trail Management Plan Environmental Assessment show that the pilot program was beneficial and replicable.

Recommendations for Future Research

Based on this study's effort to replicate previous research from other land designations into GRSM, there are three salient points that future research could address: 1) examine other variables that contribute to behavioral intent, 2) conduct qualitative interviews with participants to better understand their interpretation of LNT AIM items, and 3) assess knowledge of LNT using more robust measures. Previous research (Coulson et al., 2021; Lawhon et al., 2013, 2017; Taff et al., 2014; Vagias et al., 2014), has also indicated that there is a need to address the need

to address limitations of the LNT AIM and have put forth similar points. Future researchers would benefit from examining these studies for their findings in addition to what is outlined here.

To date, there are numerous scales and instruments that measure various aspects of the human-nature relationship and participant environmental views. Further exploration of other variables could improve the accuracy of the questionnaire in its measurement of visitor behavioral intent. Several of the most pertinent instruments include the Connectedness to Nature Scale, which explores the subjective connection that people have with nature (Mayer & Frantz, 2004); the New Ecological Paradigm Scale (Dunlap, 2008), which has been used to measure environmental concern, environmental values, and environmental beliefs of participants; and the Environmental Attitude Inventory (EAI), which was designed to evaluate a person's overall environmental attitude (Milfont & Duckitt., 2010). These three scales have been widely used in previous research and have been shown to be valid and reliable measures (Cartwright & Mitten, 2018).

As previously noted, potentially ambiguous wording of some of the LNT AIM items may have confused participants and thus skewed their answers. Future research may conduct qualitative interviews with participants to assess their understanding of questionnaire items. This may be done immediately after questionnaires are conducted. However, it is suggested that items are assessed prior to additional quantitative research using the LNT AIM. A better understanding of participant interpretation of items may allow researchers to improve wording in items and increase accuracy of their answers.

Lastly, researchers should consider an expanded measurement of visitor knowledge of LNT. This will allow for better assessment of actual, rather than self-reported knowledge as a predictor of behavioral intent. It is possible that self-reported knowledge has not been shown to

be a meaningful indicator of behavioral intent because it is comprised of one item on the LNT AIM. Robust measurements that assess visitor understanding of appropriate LNT behaviors, rather than self-reported knowledge, may demonstrate that actual knowledge is a more significant predictor of behavioral intent. Additionally, researchers could conduct a multi-year, longitudinal study to examine how knowledge of LNT may change over time (Backman et al., 2018) and potentially influence behavioral intent. Future research could explore when and how participants were first introduced to LNT and examine how participants' perceptions of LNT might change over time.

Conclusion

GRSM's increasing visitation rates is reflective of greater trends in the United States National Park system and public lands in general (Bergstrom et al., 2020; Outdoor Industry Foundation, 2021). Indirect management such as educational messaging is an important tool for public land managers to mitigate resource degradation due to inappropriate recreational behavior. This study is the first of its kind in the eastern United States and helps improve our understanding of GRSM hikers' attitudes and intentions towards LNT practices. This study also adds to a growing body of LNT-related research. These results show that appropriateness, perceived effectiveness, difficulty, and increased knowledge of are important predictors of GRSM hikers' behavioral intent. Therefore, GRSM education strategies may be more effective if they are tailored to these influencing variables. Research on other eastern U.S. public lands would fill in gaps of understanding of eastern-based recreationists and continue to improve our understanding of visitor views and behavioral intent towards LNT practices.

References

Arredondo, J. R., Marion, J. L., Meadema, F. P., & Wimpey, J. F. (2021). Modeling areal measures of campsite impacts on the Appalachian National Scenic trail to enhance ecological sustainability. *Journal of Environmental Management*. *279,* 111693-111693. https://doi.org/10.1016/j.jenvman.2020.111693

Backman, C. L., Vaske, J. J., Lawhon, B., Vagias, W. M., Newman, P., Coulson, E., & Taff, B. D. (2018). Visitors' views of leave no trace principles across a national park, a national forest, and three state parks. *Journal of Park and Recreation Administration, 36*(4), 41-54. https://doi.org/10.18666/JPRA-2018-V36-I4-8841

Ajzen, I. (1991). The theory of planned behavior. *Theories of Cognitive Self-Regulation*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Bergstrom, J. C., Stowers, M., & Shonkwiler, J. S. (2020). What does the future hold for U.S. national park visitation? estimation and assessment of demand determinants and new projections. *Journal of Agricultural and Resource Economics, 45*(1), 38-55. https://doi.org/10.22004/ag.econ.298433

Cartwright, K.S., & Mitten, D. (2018). Quantifying the Human-Nature Relationship: A User's Guide. *Research in Outdoor Education 16*, 42-70. doi:10.1353/roe.2018.0004.

Coulson, E., Park, L., Lawhon, B., Taff, D., Vagias, W., & Newman, P. (2021). Visitors' attitudes and behavioral intentions toward Leave No Trace on a national forest. *Applied Environmental Education & Communication*, *20*(1), 1–18. https://doi.org/10.1080/1533015X.2019.1617804

Dawson, C., & Hendee, J. C. (2009). *Wilderness management: Stewardship and protection of resources and values*, 4th ed. Fulcrum.

DeVellis, R. F. (2003). *Scale development: Theory and application*. Sage.

Dunlap, R. E. (2008). The new environmental paradigm scale: From marginality to worldwide use. *The Journal of Environmental Education*, *40*(1), 3–18. https://doi.org/10.3200/JOEE.40.1.3-18

Hammitt, W. E., Cole, D. N., & Monz, C. A. (2015). *Wildland recreation: Ecology and management* (Third ed.). Wiley Blackwell.

Lawhon, B., Newman, P., Taff, D., Vaske, J., Vagias, W., Lawson, S., & Monz, C. (2013). Factors influencing behavioral intentions for Leave No Trace behavior in national parks. *Journal of Interpretation Research, 18*(1), 23-28. https://doi.org/10.1177/109258721301800103

Lawhon, B., Taff, B. D., Newman, P., Vagias, W. M., & Newton, J. (2017). Understanding and influencing state park visitors' leave no trace behavioral intent. *Journal of Interpretation Research, 22*(1), 53. https://doi-org.proxy195.nclive.org/10.1177/109258721702200104

Lawhon, B., Taff, B. D., Newman, P., Vagias W. M., & Miller Z. D. (2019). Understanding attitudes and support for Leave No Trace: Informing communication strategies with frontcountry state park visitors. *Journal of Outdoor Recreation, Education, and Leadership, 11*(1), 37-52. https://doi.org/10.18666/JOREL-2019-V11-I1-9290

Leave No Trace. (2021a) *History of Leave No Trace.* Retrieved March 13, 2021,https://lnt.org/about/history

Leave No Trace. (2021b) *The 7 Principles.* Retrieved March 13, 2021, https://lnt.org/why/7-principles/

Marion, J.L. (2014). *Leave No Trace in the Outdoors*. Stackpole.

Marion, J. L. (2016). A review and synthesis of recreation ecology research supporting carrying capacity and visitor use management decision making. *Journal of Forestry, 114*(3), 339-351. https://doi.org/10.5849/jof.15-062

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*(3), 352-362. https://doi.org/10.5849/jof.15-498

Marion, J. L., & Reid, S. (2001). Development of the United States Leave No Trace programme: A historical perspective. In M.B. Usher (Ed.), *Enjoyment and Understanding of the Natural Heritage*, 81–92. The Stationery Office Ltd.; USGS Publications Warehouse. http://pubs.er.usgs.gov/publication/5211189

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, *24*(4), 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001

Milfont, T. L., & Duckitt, J. (2010). The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes. *Journal of Environmental Psychology*, *30*(1), 80–94. https://doi.org/10.1016/j.jenvp.2009.09.001

Outdoor Industry Foundation. (2021). Outdoor Participation Report 2021. Boulder, CO.

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. https://doi.org/10.7768/1948-5123.1110

Taff, D. B., Newman, P., Vagias, W. M., & Lawhon, B. (2014). Comparing day-users' and overnight visitors' attitudes concerning Leave No Trace. *Journal of Outdoor Recreation, Education, and Leadership, 6*(2), 133-146. https://doi.org/10.7768/1948-5123.1189

Vaske, J. J. (2019). *Survey research and analysis*. Sagamore-Venture.

Vagias, W. M. (2009). *An examination of the Leave No Trace visitor education program in two US National Park Service units.* Ph.D. Dissertation, Clemson University, Clemson, SC.

Vagias, W. & Powell, Robert (2010). Backcountry visitors' Leave No Trace attitudes. *International Journal of Wilderness*. *16*(3), 21-27.

Vagias, W. M., Powell, R. B., Moore, D. D., & Wright, B. A. (2012). Development, psychometric qualities, and cross-validation of the leave no trace attitudinal inventory and measure (LNT AIM). *Journal of Leisure Research, 44*(2), 234-256. https://doi.org/10.1080/00222216.2012.11950263

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*(5), 439-457. https://doi.org/10.1080/01490400.2014.912168

Visitor Experience Stewardship. (2022, January 20). Retrieved from National Park Service - Great Smoky Mountains: https://www.nps.gov/grsm/learn/management/ves.htm

REFERENCES

Alagona, P., & Simon, G. (2009). Beyond Leave No Trace. *Ethics, Place & Environment*. *12.* 17-34. 10.1080/13668790902753021.

Alagona, P., & Simon, G. (2012). Leave no trace starts at home: A response to critics and vision for the future. *Ethics, Policy & Environment*, *15*(1), 119–124. https://doi.org/10.1080/21550085.2012.672695

Alessa, L., and C.G. Earnhart. 2000. Effects of soil compaction on root and root hair morphology: Implications for campsite rehabilitation. P. 99–104 in Wilderness science in a time of change conference—*Vol. 5: Wilderness ecosystems, threats, and management*, 1999 May 23–27, Missoula, MT, Cole, D.N., S.F. McCool, W.T. Borrie, and J. O'Loughlin (comps.). USDA For. Serv., Proc. RMRS-P-15-Vol-5, Rocky Mountain Research Station, Ogden, UT.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*(4), 471-499. https://doi.org/10.1348/014466601164939

Arredondo, J. R., Marion, J. L., Meadema, F. P., & Wimpey, J. F. (2021). Modeling areal measures of campsite impacts on the Appalachian National Scenic trail to enhance ecological sustainability. *Journal of Environmental Management*. *279,* 111693-111693. https://doi.org/10.1016/j.jenvman.2020.111693

Backman, C. L., Vaske, J. J., Lawhon, B., Vagias, W. M., Newman, P., Coulson, E., & Taff, B. D. (2018). Visitors' views of leave no trace principles across a national park, a national forest, and three state parks. *Journal of Park and Recreation Administration, 36*(4), 41-54. https://doi.org/10.18666/JPRA-2018-V36-I4-8841

Ajzen, I. (1991). The theory of planned behavior. *Theories of Cognitive Self-Regulation*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Beery, T. (2014). People in nature: Relational discourse for outdoor educators. *Research in Outdoor Education, 12*(1), 1-14. https://doi.org/10.1353/roe.2014.0001

Bergstrom, J. C., Stowers, M., & Shonkwiler, J. S. (2020). What does the future hold for U.S. national park visitation? estimation and assessment of demand determinants and new projections. *Journal of Agricultural and Resource Economics, 45*(1), 38-55. https://doi.org/10.22004/ag.econ.298433

Cartwright, K.S., & Mitten, D. (2018). Quantifying the Human-Nature Relationship: A User's Guide. *Research in Outdoor Education 16*, 42-70. doi:10.1353/roe.2018.0004.

Cohen, J., & Cohen, P. (1983). Applied multiple regression/correlation analysis for the behavioral sciences. Hillsdale, NJ: Erlbaum. Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences.* Hillsdale, NJ: Erlbaum.

Cole, D. N., & Landres, P. B. (1996). Threats to wilderness ecosystems: Impacts and research needs. *Ecological Applications, 6*(1), 168-184. https://doi.org/10.2307/2269562

Conner, M., & Armitage, C. J. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology, 28*(15), 1429-1464. https://doi.org/10.1111/j.1559-1816.1998.tb01685.x

Coulson, E., Park, L., Lawhon, B., Taff, D., Vagias, W., & Newman, P. (2021). Visitors' attitudes and behavioral intentions toward Leave No Trace on a national forest. *Applied*

Environmental Education & Communication, *20*(1), 1–18. https://doi.org/10.1080/1533015X.2019.1617804

Dawson, C., & Hendee, J. C. (2009). *Wilderness management: Stewardship and protection of resources and values*, 4th ed. Golden, CO: Fulcrum Publishing.

DeVellis, R. F. (2003). Scale development: Theory and application. Thousand Oaks, CA: Sage Publication.

Dunlap, R. E. (2008). The new environmental paradigm scale: From marginality to worldwide use. *The Journal of Environmental Education*, *40*(1), 3–18. https://doi.org/10.3200/JOEE.40.1.3-18

Ells, M. D., & Monz, C. A. (2011). The consequences of backcountry surface disposal of human waste in an alpine, temperate forest and arid environment. *Journal of Environmental Management, 92*(4), 1334-1337. https://doi.org/10.1016/j.jenvman.2010.11.018

Hammitt, W. E., Cole, D. N., & Monz, C. A. (2015). *Wildland recreation: Ecology and management* (Third ed.). Wiley Blackwell.

Knight, R. L., & Gutzwiller, K. J. (1995). *Wildlife and recreationists: Coexistence through management and research*. Island Press.

Lawhon, B., Newman, P., Taff, D., Vaske, J., Vagias, W., Lawson, S., & Monz, C. (2013). Factors influencing behavioral intentions for Leave No Trace behavior in national parks. *Journal of Interpretation Research, 18*(1), *23-28.* https://doi.org/10.1177/109258721301800103

Lawhon, B., Taff, B. D., Newman, P., Vagias, W. M., & Newton, J. (2017). Understanding and influencing state park visitors' leave no trace behavioral intent. *Journal of Interpretation Research, 22*(1), *53.* https://doi-org.proxy195.nclive.org/10.1177/109258721702200104

Lawhon, B., Taff, B. D., Newman, P., Vagias W. M., & Miller Z. D. (2019). Understanding attitudes and support for Leave No Trace: Informing communication strategies with frontcountry state park visitors. *Journal of Outdoor Recreation, Education, and Leadership, 11*(1), 37-52. https://doi.org/10.18666/JOREL-2019-V11-I1-9290

Leave No Trace Center for Outdoor Ethics. (2021a) *History of Leave No Trace.* Retrieved March 13, 2021,https://lnt.org/about/history

Leave No Trace organization. (2021b) *The 7 Principles.* Retrieved March 13, 2021, https://lnt.org/why/7-principles/

Leung, Y., & Marion, J. L. (1999). Characterizing backcountry camping impacts in great smoky mountains national park, USA. *Journal of Environmental Management*, *57*(3), *193-203.* https://doi.org/10.1006/jema.1999.0303

Loynes, C. (2018). Leave More Trace. *Journal of Outdoor Recreation, Education, and Leadership, 10*(3), 179-186. https://doi.org/10.18666/JOREL-2018-V10-I3-8444

Marion, J.L. (2014). Leave No Trace in the Outdoors. Stackpole Press

Marion, J. L. (2016). A review and synthesis of recreation ecology research supporting carrying capacity and visitor use management decision making. *Journal of Forestry, 114*(3), 339-351. https://doi.org/10.5849/jof.15-062

Marion, J., Lawhon, B., Vagias, W., & Newman, P. (2011). Revisiting 'Beyond Leave No Trace'. *Ethics. Policy and Environment*. 231-237. https://doi.org/10.1080/21550085.2011.578383

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*(3), 352-362. https://doi.org/10.5849/jof.15-498

Marion, J. L., & Reid, S. (2001). Development of the United States Leave No Trace programme: A historical perspective. In M.B. Usher (Ed.), *Enjoyment and Understanding of the Natural Heritage* (pp. 81–92). The Stationery Office Ltd.; USGS Publications Warehouse. http://pubs.er.usgs.gov/publication/5211189

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, *24*, 503–515.

Milfont, T. L., & Duckitt, J. (2010). The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes. *Journal of Environmental Psychology*, *30*(1), 80–94. https://doi.org/10.1016/j.jenvp.2009.09.001

Outdoor Industry Foundation. (2021). Outdoor Participation Report 2021. Boulder, CO.

Monz, C. A., Marion, J. L., Goonan, K. A., Manning, R. E., Wimpey, J., & Carr, C. (2010). Assessment and monitoring of recreation impacts and resource conditions on mountain summits: Examples from the northern forest, USA. *Mountain Research and Development, 30*(4), 332-343. https://doi.org/10.1659/MRD-JOURNAL-D-09-00078.1

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. http://pubs.er.usgs.gov/publication/5224932

Pescott, O. L., & Stewart, G. B. (2014). Assessing the impact of human trampling on vegetation: A systematic review and meta-analysis of experimental evidence. *PeerJ (San Francisco, CA), 2*, e360-e360. https://doi.org/10.7717/peerj.360

Reed B., & Rasnake M. (2016). An assessment of coliform bacteria in water sources near appalachian trail shelters within the great smoky mountains national park. *Wilderness Environ Med. 27*(1):107-10. https://doi.org/10.1016/j.wem.2015.09.019

Reid, S. E., & Marion, J. L. (2005). A comparison of campfire impacts and policies in seven protected areas. *Environmental Management, 36*(1), 48-58. https://doi.org/10.1007/s00267-003-0215-y

Simon, G. & Alagona, P. (2009). Beyond Leave No Trace. *Ethics, Place & Environment*. *12*. 17-34. 10.1080/13668790902753021.

Sutton, S. (1998). Predicting and explaining intentions and behavior: How well are we doing? *Journal of Applied Social Psychology, 28*(15), 1317-1338. https://doi.org/10.1111/j.1559-1816.1998.tb01679.x

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. https://doi.org/10.7768/1948-5123.1110

Taff, D. B., Newman, P., Vagias, W. M., & Lawhon, B. (2014). Comparing day-users' and overnight visitors' attitudes concerning Leave No Trace. *Journal of Outdoor Recreation, Education, and Leadership, 6*(2), 133-146. https://doi.org/10.7768/1948-5123.1189

Ursem, C., Evans, C. S., Ger, K. A., Richards, J. R., & Derlet, R. W. (2009). Surface water quality along the central john muir trail in the sierra nevada mountains: Coliforms and algae. *High Altitude Medicine & Biology, 10*(4), 349-355. https://doi.org/10.1089/ham.2009.1037

Vaske, J. J. (2019). Survey research and analysis. *Sagamore-Venture*. 1807 North Federal Drive, Urbana, IL 61801.

Vagias, W. M. (2009). An examination of the Leave No Trace visitor education program in two US National Park Service units. Ph.D. Dissertation, Clemson University, Clemson, SC.

Vagias, W. & Powell, Robert (2010). Backcountry visitors' Leave No Trace attitudes. *International Journal of Wilderness*. 16. 21-27.

Vagias, W. M., Powell, R. B., Moore, D. D., & Wright, B. A. (2012). Development, psychometric qualities, and cross-validation of the leave no trace attitudinal inventory and measure (LNT AIM). *Journal of Leisure Research, 44*(2), 234-256. https://doi.org/10.1080/00222216.2012.11950263

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*(5), 439-457. https://doi.org/10.1080/01490400.2014.912168

Visitor Experience Stewardship. (2022, January 20). Retrieved from National Park Service - Great Smoky Mountains: https://www.nps.gov/grsm/learn/management/ves.html

APPENDICES

Appendix A: Verbal Consent Script

Hello, my name is David. I am a graduate student at Western Carolina University conducting research for my thesis. I am approaching visitors today to help get an understanding of visitor attitudes and perceptions about the Great Smoky Mountains National Park. Would you be willing to help by completing a short questionnaire? This questionnaire takes most visitors ~7 minutes to complete. Participation is completely voluntary and anonymous, and you can choose not to take part. You can stop at any time.

1. If they answer yes, provide visitor with laminated survey cards.
2. Ask respondent to read through the questions and provide a response for each item, which will be recorded by the interviewer on the iPad version of the survey.
3. If the party refuses the survey, ask the following question (for use in non-response bias analysis), and thank them for their time:
    a. *What is the primary activity or purpose of your visit*? (OR some other non-response question)
4. Thank respondent for his or her participation in this important research. Tell the respondent that you appreciate his or her willingness to participate in this study.

Appendix B: Modified LNT AIM

Great Smoky Mountains National Parks Visitor Survey

This study is part of a research effort by Western Carolina University and the Leave No Trace Center for Outdoor Ethics. We appreciate your willingness to participate in this study. Your participation is completely voluntary, and all the answers you give are confidential and anonymous. Filling out this questionnaire will take approximately 10 minutes. If you do not wish to continue, you can stop at any time. Thank you for your participation in this important research.

1. Please indicate how INAPPROPRIATE or APPROPRIATE you think each of the following activities is for a visitor to do in Great Smoky Mountains National Park. *Circle the number of your response for each statement.*

Activities	Very Inappropriate			Neutral			Very Appropriate
a. Experiencing parks and historic sites by not preparing for all types of weather or hazards before I get on a trail	1	2	3	4	5	6	7
b. Scheduling my trip during times of high use to reduce overall impact	1	2	3	4	5	6	7
c. Traveling off the trail to experience the natural environment	1	2	3	4	5	6	7
d. Traveling around muddy spots on the trail	1	2	3	4	5	6	7
e. Disposing of human waste in a lake, river, or stream if there are no public facilities	1	2	3	4	5	6	7
f. Carrying all litter out, leaving only food scraps behind	1	2	3	4	5	6	7
g. Keeping a single item like a rock, plant, stick, or feather as a souvenir	1	2	3	4	5	6	7
h. Moving rocks and/or logs to make a campsite more comfortable	1	2	3	4	5	6	7
i. Using a stove for cooking instead of a fire	1	2	3	4	5	6	7
j. Having a small campfire in an existing fire ring	1	2	3	4	5	6	7
k. Dropping food on the ground to provide wildlife a food source	1	2	3	4	5	6	7
l. Approaching wildlife to take a photo	1	2	3	4	5	6	7
m. Traveling side by side with members of my group on existing trails	1	2	3	4	5	6	7
n. Taking a break along the edge of the trail	1	2	3	4	5	6	7

2. Please indicate the level at which you think each of the following activities would REDUCE NEGATIVE

IMPACTS in Great Smoky Mountains National Park. *Circle the number of your response for each statement.*

Participating in the following activities in Great Smoky Mountains National Park would reduce impact…	Never			Sometimes			Every time
a. Preparing for all types of weather, hazards, or emergencies before I get on a trail	1	2	3	4	5	6	7
b. Scheduling trip to avoid times of high use	1	2	3	4	5	6	7
c. Staying on designated or established trails	1	2	3	4	5	6	7
d. Traveling single file in the middle of the trail, even when wet or muddy	1	2	3	4	5	6	7
e. Carrying out all litter, even crumbs, peels, or cores	1	2	3	4	5	6	7
f. Never removing objects from the area, even a small item like a rock, plant, stick, or feather	1	2	3	4	5	6	7
g. g. Using a stove for cooking instead of a fire	1	2	3	4	5	6	7
h. h. Having a small campfire in an existing fire ring	1	2	3	4	5	6	7
i. Never approaching, feeding, or following wildlife	1	2	3	4	5	6	7
j. Taking breaks away from the trail and other visitors	1	2	3	4	5	6	7

3. The same activities are listed below. Regardless of how effective you think each of the following activities are, please indicate how DIFFICULT you think each of the following activities would be for a visitor to do in Great Smoky Mountains National Park. *Circle the number of your response for each statement.*

Activities	Not at all Difficult			Moderately Difficult			Extremely Difficult
a. Preparing for all types of weather, hazards, or emergencies before I get on a trail	1	2	3	4	5	6	7
b. Scheduling trip to avoid times of high use	1	2	3	4	5	6	7
c. Staying on designated or established trails	1	2	3	4	5	6	7
d. Traveling single file in the middle of the trail, even when wet or muddy	1	2	3	4	5	6	7
e. Carrying out all litter, even crumbs, peels, or cores	1	2	3	4	5	6	7
f. Never removing objects from the area, not even a small item like a rock, plant, stick, or feather	1	2	3	4	5	6	7
g. Using a stove for cooking instead of a fire	1	2	3	4	5	6	7
h. Having a small campfire in an existing fire ring	1	2	3	4	5	6	7
i. Never approaching, feeding, or following wildlife	1	2	3	4	5	6	7
j. Taking breaks away from the trail and other visitors	1	2	3	4	5	6	7

4. The same activities are listed below. In COLUMN A, tell us if you DO each activity by *circling* NEVER, SOMETIMES or ALWAYS.

In COLUMN B, please indicate how LIKELY are you to do the activity in the future by *circling the number of your response for each statement.*

Activities	Column A Do You Do This?			Column B How Likely Are You To Do This In The Future? Not at all Likely						Extremely Likely
a. Prepare for all types of weather, hazards, or emergencies before I get on a trail	Never	Sometimes	Always	1	2	3	4	5	6	7
b. Schedule trip to avoid times of high use	Never	Sometimes	Always	1	2	3	4	5	6	7
c. Stay on designated or established trails	Never	Sometimes	Always	1	2	3	4	5	6	7
d. Travel single file in the middle of the trail, even when wet or muddy	Never	Sometimes	Always	1	2	3	4	5	6	7
e. Carry out all litter, even crumbs, peels, or cores	Never	Sometimes	Always	1	2	3	4	5	6	7
f. Remove objects from the area, even a small item like a rock, plant, stick, or feather	Never	Sometimes	Always	1	2	3	4	5	6	7
g. Use a stove for cooking instead of a fire	Never	Sometimes	Always	1	2	3	4	5	6	7
h. Have a small campfire in an existing fire ring	Never	Sometimes	Always	1	2	3	4	5	6	7
i. Approach, feed, or follow wildlife	Never	Sometimes	Always	1	2	3	4	5	6	7
j. Take breaks away from the trail and other visitors	Never	Sometimes	Always	1	2	3	4	5	6	7

5. Please indicate your level of agreement with the following statements. *Circle the number of your response for each statement.*

	Not at all under my control			Neutral			Completely under my control
a. How I act while in the Great Smoky Mountains National Park is…	1	2	3	4	5	6	7
b. The way I act while recreating in the Great Smoky Mountains National Park is…	1	2	3	4	5	6	7

c. My recreation practices in the Great Smoky Mountains National Park are…	1	2	3	4	5	6	7
d. The way the individuals in my group act while in the Great Smoky Mountains National Park is…	1	2	3	4	5	6	7

6. How FAMILIAR are you with the Leave No Trace Center for Outdoor Ethics? *Please circle only one number.*

Not at all Familiar	Slightly Familiar		Moderately Familiar	Quite Familiar	Extremely Familiar
0	1	2	3	4	5	6

7. How would you describe your current knowledge of "Leave No Trace" practices? *Please circle only one number.*

No Knowledge	Very Limited	Limited	Average	Above Average	Extensive	Expert
0	1	2	3	4	5	6

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

Activities	Strongly Disagree			Neutral			Strongly Agree
a. Sometimes it is too difficult to practice "Leave No Trace"	1	2	3	4	5	6	7
b. Practicing "Leave No Trace" takes too much time	1	2	3	4	5	6	7
c. Practicing "Leave No Trace" violates the rights of individuals to do as they please in the outdoors	1	2	3	4	5	6	7
d. Practicing "Leave No Trace" does not reduce the environmental harm caused by recreation	1	2	3	4	5	6	7
e. Practicing "Leave No Trace" effectively protects the environment for future generations to enjoy	1	2	3	4	5	6	7
f. Practicing "Leave No Trace" enhances my outdoor experience	1	2	3	4	5	6	7
g. It is important that all visitors practice "Leave No Trace"	1	2	3	4	5	6	7
h. It is important that Park regulations require all visitors to practice "Leave No Trace"	1	2	3	4	5	6	7
i. The people I recreate with believe it is important to practice "Leave No Trace"	1	2	3	4	5	6	7
j. In general, the opinions of others have little effect on my practicing "Leave No Trace"	1	2	3	4	5	6	7
k. I practice "Leave No Trace" because the people I recreate with believe it is important	1	2	3	4	5	6	7
l. I practice "Leave No Trace" because the park regulations state that I should do so	1	2	3	4	5	6	7

Activities	Strongly Disagree			Neutral			Strongly Agree
m. It is important to practice "Leave No Trace" techniques when in the park	1	2	3	4	5	6	7
n. If I learned my actions in the park damaged the environment, I would change my behavior	1	2	3	4	5	6	7
o. I get upset when I see other individuals in the park not following "Leave No Trace" practices	1	2	3	4	5	6	7
p. I insist that "Leave No Trace" practices are followed by all members of my group	1	2	3	4	5	6	7

9. How FREQUENTLY in the past 3 months, did you do any of the following activities related to "Leave No Trace?" *Circle the number of your response for each statement*.

Activities	Never			Occasionally			Frequently
a. Talk with others about Leave No Trace	1	2	3	4	5	6	7
b. Read articles or books about Leave No Trace	1	2	3	4	5	6	7
c. Take Leave No Trace course or attend a workshop	1	2	3	4	5	6	7
d. Teach others about Leave No Trace	1	2	3	4	5	6	7
e. View websites or social media ("www.LNT.org," Facebook, YouTube or Twitter)	1	2	3	4	5	6	7
f. Other (please specify):							

10. Where did you first learn about "Leave No Trace?" *Please check only **one** answer.*

o Leave No Trace website o Information kiosk/park literature o Popular media (magazines, books)

o Course or workshop o Park personnel/ranger talk o Other (please specify):_____

11. What is the primary purpose of your visit? *Please select only **one** answer.*

o Hiking o Mountain biking o Fishing o Picnicking o Historical Exhibits

o Camping o Boating o Climbing o Sightseeing o Other (please specify):_____

12. How many times have you visited this park in the past 12 months? *Please check only **one** answer*.

o No visits o 1-2 visits o 3-5 visits o 6-10 visits o 11-20 visits

o 21-30 visits o 31-40 visits o 41-50 visits o More than 50 o Other (please specify):_____

13. It bothers me when I see trash left behind by others in Great Smoky Mountains National Park. *Circle the number of your response*.

Strongly Disagree		Disagree	Neutral	Agree		Strongly Agree
1	2	3	4	5	6	7

14. If I learned that taking all of my trash out of the park or when I leave would help keep fees low, I would take all of my trash out of the parks. *Circle the number of your response.*

Strongly Disagree		Disagree	Neutral	Agree		Strongly Agree
1	2	3	4	5	6	7

15. What is your sex? o Male o Female

16. In what year were you born? _____

17. What is your zip code/country code? _____

Thank you for participating in this research study. Your input is very important to Western Carolina University and the Leave No Trace Center for Outdoor Ethics.

Appendix C: Research Permit

SCIENTIFIC RESEARCH AND COLLECTING PERMIT Grants permission in accordance with the attached general and special conditions United States Department of the Interior National Park Service Great Smoky Mountains	Study#: GRSM-02165 Permit#: GRSM-2021-SCI-2165 Start Date: Sep 24, 2021 Expiration Date: Dec 31, 2021 Coop Agreement#: Optional Park Code:

Name of principal investigator:
Name: David Schafer **Phone:**828-429-9486 **Email:**dschafer1@catamount.wcu.edu

Name of institution represented:
Western Carolina University

Additional investigators or key field assistants:

Name: Andrew Bobilya	**Phone:** 828-227-3326	**Email:** ajbobilya@email.wcu.edu
Name: Ben Lawhon	**Phone:** 303-442-8222. Extension 104	**Email:** ben@lnt.org

Study Title:
Hikers' Understanding of Leave No Trace in the Great Smoky Mountains National Park.

Purpose of study:
The purpose of this study is to explore hikers' understanding of Leave No Trace (LNT) in the Great Smoky Mountains National Park (GRSM) through a quantitative survey that measures hikers' attitudes towards LNT, perceived effectiveness of LNT practices, perceived difficulty of practicing LNT, and behavioral intent towards practices LNT principles. The purpose of gathering data on these four variables is to determine which of has the most influence on visitor understanding and practice of LNT.

Subject/Discipline:
Social Science

Locations authorized:
You are limited to administering your survey at trailheads in GRSM, especially Clingmans Dome, Newfound Gap, Deep Creek, and Elkmont. You may NOT ask hikers already more than a couple meters along the trails from the trailheads to participate in your study.

Transportation method to research site(s):
The researcher will drive to trailheads and conduct surveys in-person.

THIS PERMIT DOES NOT AUTHORIZE YOU TO PARK OUTSIDE OF DESIGNATED PARKING AREAS…PLEASE PLAN YOUR FIELD SCHEDULE TO ARRIVE AT POPULAR DESTINATIONS EARLY IN THE MORNING TO INSURE ACCESS TO A DESIGNATED PARKING PLACE. Please be respectful of park visitors, employees, and neighbors; a permit to conduct research within the park does not convey or imply permission to conduct research on private land surrounding the park.

Possession of a signed research permit does not in itself guarantee access to all areas authorized under the permit. All or portions of the Park may be closed at any time because of weather, road work, or other reasons. Check for current park conditions on-line before traveling to the park to ensure the roads and trails you wish to use are accessible: https://twitter.com/smokiesroadsnps and https://www.nps.gov/grsm/planyourvisit/conditions.htm

Collection of the following specimens or materials, quantities, and any limitations on collecting:
Please provide the Park with copies of your raw data, as well as your thesis and any publications related to this study.

Do not collect personally identifiable information on participants. The demographic data questions in the survey instrument shared with this office are acceptable.

***IF AT ANY TIME IN THE PROCESS A VISITOR CHOOSES TO NOT INTERACT WITH YOU OR TO STOP THE SURVEY, accept that this visitor will not complete the survey and do not pursue, and thank the visitor for any time they provided you.

Name of repository for specimens or sample materials if applicable:

NPS General Conditions for Scientific Research and Collecting Permit (available at the RPRS HELP page) apply to this permit. The following specific conditions or restrictions, and any attached conditions, also apply to this permit:
***Issuance of this permit does not indicate sponsorship or collaboration with this study. The National Park Service has simply determined that this independent research may be conducted within Great Smoky Mountains National Park with minimal impact on

visitor experience or Park resources and will assist the researchers where needed to insure minimal impact.***

READ AND ABIDE BY NPS GENERAL CONDITIONS #1-18, A-I (enclosed).

For any actions involving the Eastern Band of Cherokee Indians, you must be in compliance with EBCI research policy. This permit does not convey any waver of EBCI policy, rules, or law.

THE PRINCIPAL INVESTIGATOR AND ALL CO-INVESTIGATORS MUST CARRY A COPY OF THE SIGNED RESEARCH PERMIT WITH THEM AT ALL TIMES WHILE WORKING IN THE PARK AND PRESENT IT TO ANY PARK EMPLOYEE WHO ASKS TO SEE IT.

PROVIDE THE RESEARCH COORDINATOR WITH THE DATES OF YOUR WORK IN THE PARK AS SOON AS YOU KNOW THEM (it is acceptable to provide a range of dates if you are working both inside and outside the park over a period of time).

This permit is made upon the express condition that the United States, its agents and employees shall be free from all liabilities and claims for damages and/or suits for or by reason of any injury, injuries, or death to any person or persons or property of any kind whatsoever, whether to the person or property of the Permittee, its agents or employees, or third parties, from any cause or causes whatsoever while in or upon said premises or any part thereof during the term of this permit or occasioned by any occupancy or use of said premises or any activity carried on by the Permittee in connection herewith, and the Permittee hereby covenants and agrees to indemnify, defend, save and hold harmless the United States, its agents, and employees from all liabilities, charges, expenses and costs on account of or by reason of any such injuries, deaths, liabilities, claims, suits or losses however occurring or damages growing out of the same. Permittee promises to cooperate with the NPS in the investigation and defense of any claims that may be filed with the NPS arising out of the activities of the cooperator, its agents, and employees.

YOU ARE REQUIRED TO SUBMIT AN ONLINE REPORT OF YOUR RESEARCH ACTIVITIES EACH YEAR, and you must mail two copies of your final research report to our office upon completion of your project. Even if you did no work in the park during a calendar year, you must go online and say so. The report can be submitted at the end of your year's work at any time with your research account password that you used to submit your permit. A reminder to submit your Investigator's Annual Report will be distributed electronically to permit holders at the end of the calendar year by Washington.

Breach of any of the terms of this permit or for violation of park regulations will be grounds for revocation of this permit and denial of future permits.

Summary of permitted field methods and activities:

This survey was provided by the Leave No Trace Center for Outdoor Ethics, which is a partner in the study. David Schafer will only interview adults age 18 and older who provide verbal consent to take the survey. The population will be backpackers and day-hikers at the aforementioned trailheads within GRSM. David Schafer will attempt to survey 150 people from each category for a total of 300 participants. Data collection will begin October 18 and last for one month, or until 300 visitors have been surveyed. If the visitor provides verbal consent, then David will hand them a laminated sheet of the survey. The visitor will verbally state their answers while David records them on a tablet device. This will ensure accuracy and safekeeping of the data that is collected. Only one visitor will be surveyed at a time. Upon completion, visitors will be thanked for their time and contribution to the study.

Recommended by park staff(name and title):

Reviewed by Collections Manager:

Yes____ No____ n/a

Approved by park official:

Date Approved: 22 September, 2021

Title:

Biologist / Research Coordinator

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

(Principal investigator's signature) (Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

GENERAL CONDITIONS
For
SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior
National Park Service

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.

2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.

3. **False information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.

4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.

5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.

6. **Collection of specimens (including materials)** - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.
- Collection methods shall not attract undue attention or cause unapproved damage, depletion, or disturbance to the environment and other park resources, such as historic sites.
- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit.Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status(e.g., herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property.The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog.Unless exempted by additional park - specific stipulations, the permittee will complete the labels and catalog records and will provide accession information.It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for

scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement(CRADA) or other approved benefit - sharing agreement with the NPS.The sale of collected research specimens or other unauthorized transfers to third parties is prohibited.Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent(20 %) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against the permittee.

7. **Reports** - - The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff.Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and / or other materials may also be requested.The permittee is responsible for the content of reports and data provided to the National Park Service

8. **Confidentiality** - - The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

9. **Methods of travel** - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

10. **Other permits** - The permittee must obtain all other required permit(s) to conduct the specified project.

11. **Insurance** - If liability insurance is required by the NPS for this project, then documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.

12. **Mechanized equipment** - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.

13. **NPS participation** - The permittee should not anticipate assistance from the NPS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.

14. **Permanent markers and field equipment** - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional park specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by staff at individual parks.

15. **Access to park and restricted areas** - Approval for any activity is contingent on the park being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional park specific stipulations attached to this permit.

16. **Notification** - The permittee is required to contact the park's Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit.Ideally this contact should occur at least one week prior to the initial visit to the park.

17. **Expiration date** - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

18. **Other stipulations** - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits.

Appendix D: Letter of Cooperation

Leave No Trace™
Center for Outdoor Ethics | LNT.org

September 8, 2021

David Schafer
Graduate Student
Experiential and Outdoor Education
Western Carolina University
Cullowhee, NC 28723

David,

It is our understanding that you will conduct research on public understand and practice of Leave No Trace Principles in the Great Smoky Mountains National Park (GRSM). This is in accordance with your thesis requirement of your Experiential and Outdoor Education M.S. Program at Western Carolina University (WCU). The study will be conducted via quantitative surveys of day hikers and backpackers in GRSM. Permit approval will be acquired from GRSM staff prior to research.

It is understood that this collaborative study will be conducted in cooperation with WCU and the Leave No Trace Center for Outdoor Ethics (the Center). The study will commence in October of 2021 may continue through May of 2022. The Center will provide a quantitative survey instrument that has been utilized in numerous studies which can be specifically tailored for data collection in GRSM. Additionally, the Center will provide guidance on analysis of the collected data. Ben Lawhon of the Center will serve as a member in David Schafer's thesis committee. There will be no financial assistance or obligation for either WCU or the Center.

We are excited to undertake this study with you as we believe it will contribute to the understanding of visitor behavior in GRSM and of Leave No Trace broadly, and will enhance future education programs and contribute to the literature that informs other similar studies.

Sincerely,

Ben Lawhon, MS
Senior Director of Research and Consulting
Leave No Trace Center for Outdoor Ethics
303.442.8222 x104
Ben@LNT.org

PHONE 303.442.8222 FAX 303.442.8217 ADDRESS P.O. Box 997, Boulder, CO 80306 LNT.ORG

Appendix E – LNT Visitor Survey Log

GRSM LNT Study Surveyor Datasheet							
Research Site		Date (mm/dd/yy)		Time Start	Time End	Weather	
Visitor Information							
Time	Activity	Consent? Y/N	Survey #	# of Adults	# of Children	Non-response Question?	Notes

Appendix F – GRSM Sampling Schedule

GRSM Sampling Schedule - November 2021

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
31	1 Deep Creek Trailhead 9AM-4PM	2	3	4	5 Little River Trailhead 9AM-4PM	6 Newfound Gap/Deep Creek Trailhead 9AM-4PM
7	8	9	10 Newfound Gap 9AM-3PM	11	12 Little River Trailhead 9AM-3PM	13 Deep Creek Trailhead 9AM-3PM
14	15	16	17 Newfound Gap 9AM-3PM	18	19 Deep Creek Trailhead 9AM-3PM	20 Little River Trailhead 9AM-3PM
21 Alum Cave Trailhead 9AM-3PM	22	23	24	25	26	27

28	29 Alum Cave Trailhead 9AM-3PM	30				

GRSM Sampling Schedule - December 2021

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3 Deep Creek Trailhead 9AM-3PM	4 Newfound Gap 9AM-3PM
5 Alum Cave Trailhead 9AM-3PM	6 Little River Trailhead 9AM-3PM	7	8	9	10	~~11~~
12	13	14	15	16	17	18

19	20	21	22	23	24	25
26	27	28	29	30	31	30

Times of survey administration

The researcher will spend each day at one site due to difficulty of travel between sites. Time periods will start at 9AM and end at 3-4PM depending on visitor traffic.

Preparation for sampling in GRSM

The researcher will bring the following required equipment to the site:

- A watch or cell phone for noting time
- Datasheets/clipboard/pens
- Mask or face cover
- Sanitary wipes
- Site map(s) and driving/hiking directions to sampling location
- Insect repellant / sunscreen
- Hat or clothing with Western Carolina University logo
- Nametag
- Personal food/water

Before departure, the researcher will check the hourly weather forecast for the survey area. Researcher will arrive at least 15 minutes before scheduled survey session start time to access the study site and fill out the following header information on the appropriate datasheet.

- Date of observation session (mm/dd/yyyy)
- Start time
- Weather (sky, wind, and precipitation conditions that occur at the beginning of the observation session)
- Air temperature (°F) estimated to the nearest 10 degrees
- Location

Unforeseen cancelations due to weather, illness, etc.

A session is "cancelled" or finished early if the weather meets any of the following conditions: 1) no visitors could be expected; 2) the researcher would be miserable working in those conditions; 3) conditions would put the researcher's health or safety at risk; or 4) conditions prevent the survey from being effectively administered (e.g. blowing rain that would damage survey equipment). If 30 minutes or more are missed during an observation session, that session will be treated as cancelled. Similarly, if one hour or more of a survey administration's session is missed for any reason (e.g., weather, ill surveyor), that session will be treated as cancelled. Cancelled sessions or sessions missed for weather, sickness or other reasons will be made up on the next similar day the researcher will be available. If a survey administration session is shortened due to inclement weather or other unexpected event but not cancelled (i.e., the session is at least two hours in length), this will be documented in the "end time" and "notes" sections of the appropriate datasheet (see Appendix A and B). If a session is started late, it will continue late by the same amount of time to the extent possible given availability, time of day, weather conditions, etc.