

Strategic Research Agenda



Cover Photo: Visitor use research at Grand Canyon National Park.

Developed by Dr. Derrick Taff, Visiting Social Scientist, Associate Professor, Recreation, Park and Tourism Management, Penn State University, with contributions from Drs. Peter Newman, Jeff Marion, Ashley D'Antonio, William Rice, Zach Miller, Jennifer Newton, and Wade Vagias

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LEAVE NO TRACE SCIENCE AND RESEARCH

The purpose of this document is to enhance, expand and elevate Leave No Trace's research arm to further demonstrate efficacy and credibility in the world of stewardship education by introducing key research priorities that merit advancement.

Leave No Trace is grounded in science and research and has been since its origins in the field of recreation ecology. This has evolved over the years as recreation-related impacts and associated monitoring has incorporated human dimensions of natural resources, striving to understand how and why humans cause impacts and, ultimately, how to influence behaviors to decrease recreational-related impacts. While this document highlights both recreation ecology and human dimensions of natural resources research needs, coupled social-ecological research is optimal.

With regard to methods, we advocate for moving beyond self-reported data when possible, measuring actual behaviors and, ideally, behavior change following experimental design interventions. We support rigorous experimental designs that apply robust sample sizes per control and treatment(s) while adhering to best practices for human dimensions of natural resources and recreation ecology science. While science onsite with actual recreationists is always valuable, we also recognize the usefulness of big data and larger panel-based research for understanding larger-scale trends. Finally, any Leave No Trace-based research requires institutional review board approval, local park and protected area permitting approvals, and, if federally supported, approval from the Federal Office of Management and Budget.

In the following pages, we highlight our strategic research priorities from 2023 to 2028. While these are focus areas for the organization, we welcome innovative ideas that adhere to our mission that move beyond these suggestions. Additionally, while we have suggested example research questions for each of our strategic research areas, we anticipate that all research applicants will advance these concepts with the proposed research.

RESEARCH PRIORITIES

As stated above, at the core of Leave No Trace is understanding recreation-related impacts and striving to mitigate those impacts in a manner that protects both the resources and the recreational experiences that depend upon those resources. With that in mind, research that pairs both ecological and social sciences, measuring the influences of Leave No Trace interventions is the top priority for the Leave No Trace organization. Much of this work can be explored through the 7 Leave No Trace Principles. However, other aspects, such as effective communication and education of Leave No Trace and equitable access to the organization's resources, are also important research areas that perpetually need to be advanced. Finally, while Leave No Trace originated in the United States, branches and educational materials have flourished in other countries, as has research (e.g., North et al., 2023; Blye and Halpenny, 2020, etc.). This document focuses on advancing research in the United States, but that does not negate the need for expanding research to other areas and across other cultural orientations.

The following areas (in no particular ranked order) highlight our current strategic research priorities:

PRE-POST INTERVENTION, COUPLED SOCIAL-ECOLOGICAL

Research that examines both social (i.e., perceptions and actual behaviors) and ecological (i.e., level and amount of recreation impact on natural resources; species behavior) before and after a Leave No Trace-based intervention is the most crucial research for the Leave No Trace organization. For example, Setina et al., 2020 examined different types of Leave No Trace communication interventions on littering, tree damage, and surface disposal of human waste. This study is a good example of pairing both social and ecological data to determine the effectiveness of varying Leave No Trace strategies.

► Why are these studies important for Leave No Trace?

While these types of projects are arduous and often take sizable amounts of time to determine ecological responses to interventions, these types of data are extremely valuable to Leave No Trace as they inform onsite efficacy. These studies also inform ways that Leave No Trace training and education may improve and adapt based on onsite conditions. Finally, these projects demonstrate the strength (and areas that may need improvement) of Leave No Trace in assisting with onsite management of visitors (i.e., requiring less staffing if visitors are following effective Leave No Trace practices and reducing maintenance costs).



Figure 1. Recreation Ecology research in Grand Staircase-Escalante National Monument

► Within this priority, example research themes and related questions include...

- How do group sizes influence social and ecological conditions?
- How do varying outdoor recreation activities influence social and ecological conditions?
- What are the pre-post social and ecological conditions following a Leave No Trace intervention?

UNDERSTANDING AND REACHING NEW OUTDOOR RECREATIONISTS

One of the reasons Leave No Trace was created stems from perpetual increases in outdoor recreation in parks and protected areas. With the exception of just a few periods of time within the past century, parks and protected areas have witnessed steady, if not substantive, increases in use. This increase has been exacerbated amidst the COVID-19 pandemic, as several global studies, and in particular in the U.S., have documented a significant increase in outdoor recreation behaviors. For example, research suggests that approximately 50% of the U.S. now participates in outdoor recreation regularly (i.e., at least once per month), and of these individuals, 20% are new to outdoor recreation as a result of the pandemic (Taff et al., 2021).

► Why are these studies important for Leave No Trace?

It is important to understand both current and also new outdoor recreationists, their behaviors, activities, and desires for their recreational experiences. In particular, it is vital that the Leave No Trace organization know how to reach these outdoor recreationists with education and training and subsequently evaluate the effectiveness of these strategies in mitigating recreational impacts. With regard to methods, we seek data regarding both onsite recreationists at specific locations, as well as data at a larger scale, perhaps collected through regional and national panels.



Figure 2. Bouldering study in Rocky Mountain National Park

► Within this priority, example research themes and related questions include...

- What educational strategies (e.g., applications, onsite, etc.) are most effective for reaching current and new outdoor recreationists?
- Are there new outdoor recreation activities that must be considered with regard to managing social and ecological impacts?

LEAVE NO TRACE EDUCATION AND TRAINING EFFECTIVENESS

Leave No Trace is the leading education and training facilitator regarding minimum impact outdoor recreation behaviors, but we are perpetually seeking ways to further understand our efficacy and educate beyond the backcountry. We are interested in understanding how we can improve our curriculum and delivery and continue to diversify our audience.

► **Why are these studies important for Leave No Trace?**

Research to date has documented that our educational programming is effective, but we are always seeking ways to improve. Furthermore, technology is rapidly changing, and preferences for educational delivery shift accordingly. Thus, we seek ways to expand our educational reach through a variety of mediums through the most effective and equitable curriculum approaches available.

► **Within this priority, example research themes and related questions include...**

- Are online trainings as effective as in-person Leave No Trace education lessons?
- What are the most effective ways to train future Leave No Trace instructors?
- What types of educational strategies are most effective at teaching youth Leave No Trace practices, and how does that change through various stages of human development?

BARRIERS TO COMPLIANCE

Several Leave No Trace-specific studies have documented that individuals are more likely to perform behaviors that are perceived as easy and effective at protecting natural resources (Lawhon et al., 2013). To date, this research has informed education and training associated with several of the Leave No Trace Principles, but gaps remain. For example, certain behaviors have been noted as being more difficult than others for some individuals (e.g., Respecting Wildlife, Traveling and Camping on Durable Surfaces, and Disposing of Waste Properly) and continue to result in both social and ecological impacts in our parks and protected areas. Manning (2003) suggests that many types of impacts can be addressed with information and education, such as that provided through Leave No Trace.



Figure 3. Human waste impacts were documented through a Recreation Ecology project at Grand Staircase-Escalante National Monument.

Table 1. Feasibility of Information and Education to Address Management Issues (adapted from Manning, 2003).

Type of Problem	Example	Potential Effectiveness of Information/Education (Leave No Trace)
Illegal Actions	Theft of artifacts; use of Wilderness by motorized off-road vehicles	Low
Careless Actions	Littering; Shouting	Moderate
Unskilled Actions	Selecting an unsustainable campsite	High
Uninformed Actions	Camping in sight or sound of wildlife habitat	Very High
Unavoidable Actions	Trampling ground cover vegetation at campsite	Low



Figure 4. Visitor photographing wildlife in Grand Teton National Park.

► Why are these studies important for Leave No Trace?

Understanding remaining barriers to recommended compliance will enable the Leave No Trace organization to continue developing strategies for mitigating perceived difficulties through education and training, and potentially their partners (gear manufacturers, land managers, etc.) that can aid with making certain behaviors easier to perform.

► Within this priority, example research themes and related questions include...

- What barriers remain for properly disposing of human waste, and how do these differ by landscape, visitor demographics, infrastructure, and regulatory practices?
- What barriers remain for mitigating visitor impacts on wildlife? Despite a suite of interventions stemming from Leave No Trace recommendations, parks, and protected areas continue to see impacts from visitors getting too close, feeding, letting dogs off-leash in leashed zones, and even petting wildlife, thus perpetuating habituation.
- What are the barriers to increasing behaviors associated with Being Considerate of Others, particularly as existing and new outdoor recreation activities create spatial and temporal user conflicts?

UNDERSTANDING THE ROLE OF PLANNING AND PREPARING WITH ONSITE BEHAVIORS

Planning Ahead and Preparing is one of the most crucial Leave No Trace Principles, and while self-reported behaviors associated with this Principle suggest that it is easy to perform (Lawhon et al., 2013), to date, no research has examined how planning and preparing can influence onsite social and ecological conditions. As the presence and use of applications, reservation systems, and real-time information delivery increases, the potential for education and training associated with Planning Ahead and Preparing is significant.

► Why are these studies important for Leave No Trace?

Understanding remaining barriers to recommended compliance will enable the Leave No Trace organization to continue developing strategies for mitigating perceived difficulties through education and training, and potentially their partners (gear manufacturers, land managers, etc.) that can aid with making certain behaviors easier to perform.

► Within this priority, example research themes and related questions include...

- When and how should visitors receive Planning Ahead and Preparing information? Does this differ by location, demographic, and/or activity type?
- What is the role of Planning Ahead and Preparing with Preventative Search and Rescue programs?
- How can reservation system-based Planning Ahead and Preparing strategies influence onsite Leave No Trace-related behaviors?
- Can big data predictive modeling using internet-based Planning Ahead and Preparing interventions be useful in understanding subsequent onsite behaviors at large scale?



Figure 5. Visitor interacting with Leave No Trace treatment study at Denali National Park.

YOUTH AND CAUSAL NATURE CONNECTION

Several studies have documented the effectiveness of Leave No Trace youth-focused education (Ahl et al., 2022; Miller et al., 2014; Schwartz et al., 2018), and one study noted the potential connection between Leave No Trace education and perceived nature connection with youth (Schwartz et al., 2018). While these data are encouraging, questions remain regarding the causal nature of Leave No Trace education on youth behaviors and, specifically, their perceived connection to nature.

► Why are these studies important for Leave No Trace?

To date, causal research has only examined the role of the “Bigfoots Playbook” training and Leave What You Find on affinity and responsibility toward nature and self-reported nature connection (Ahl et al., 2022; Schwartz et al., 2018). While these efforts advanced strategies for Leave No Trace youth education, more research is needed to examine educational influences on a variety of Leave No Trace-related behaviors and to understand both the correlation and potential causation with increased nature connection. These efforts will inform more effective educational strategies and training for the educators that facilitate these youth opportunities.

► Within this priority, example research themes and related questions include...

- What Leave No Trace youth educational strategies are most effective at instilling long-term perceived nature connection?



Figure 6. Leave No Trace researcher surveying visitors in Yellowstone National Park.

- What is the role of youth Leave No Trace education and trans-generational learning (e.g., can Leave No Trace youth education influence caregivers perceptions and behaviors)?
- What is the role of Leave No Trace youth educational strategies and everyday environmentally responsible behaviors?
- How can Leave No Trace youth educational strategies influence perceptions and behaviors associated with pertinent environmental and social issues (e.g., climate change; social equity)?

BEYOND THE BACKCOUNTRY

Tourism

We recognize the role that Leave No Trace can play in protected areas across the spectrum, but also in everyday environmentally responsible behaviors at home and with visitors at sustainable tourism destinations (and those communities aspiring to be sustainable tourism destinations). We also recognize the importance of reaching demographics beyond the backcountry or wilderness settings.



Figure 7. Leave No Trace education at an event at Eldora Mountain Resort.

Sustainable Events

As the importance of sustainable events, from music festivals to cultural gatherings, increases, we recognize that Leave No Trace can play a significant role in promoting and protecting social and ecological conditions in these settings. Research regarding how and when to engage with visitors and what types of onsite infrastructure promote sustainable behaviors (and ultimately mitigate impacts) is needed to inform education, training, and guidance that will sustain these types of events.

Everyday Environmentally Responsible Behaviors

Leave No Trace research indicates that individuals that have engaged with Leave No Trace participate in public and private environmentally responsible behaviors as much as two times more frequently than the general public (Mateer et al., 2022). While these data point to the correlational nature of Leave No Trace and more sustainable everyday practices, the organization would like to understand the role of Leave No Trace, specifically influencing public and private environmentally responsible behaviors in protected areas and at individuals' homes and communities. Thus, we seek to understand the causal relationship of engagement with Leave No Trace on environmentally responsible behaviors.



Figure 7. Litter at National Mall. ►

BEYOND THE BACKCOUNTRY

(continued)

► **Why are these studies important for Leave No Trace?**

The origins of Leave No Trace stem from the backcountry, but research suggests that individuals that engage with primitive/wilderness-based recreation likely already engage in Leave No Trace behaviors (Taff et al., 2014), but as outdoor recreation increases (particularly post-pandemic), it is important for our organization to reach audiences beyond the backcountry. Increasing our reach through scientifically-informed approaches will improve our efficacy across the spectrum of protected areas (urban to remote) and at home to the backcountry.

► **Within this priority, example research themes and related questions include...**

- What is the influence of pre-post community engagement and efficacy of Leave No Trace tourism-focused efforts?
- What are different cultural interpretations of Leave No Trace behaviors, and how does that inform diverse approaches to educating and training others in Leave No Trace?
- What is the economic impact (via preservation of nature and natural resources and social/visitor experiences) of Leave No Trace on a tourism-driven community?
- What is the role of Leave No Trace in the education of visitors to gateway communities of parks and protected areas, and how does that influence behaviors within the parks and protected areas?
- What is the relationship (e.g., causal, correlation) of Leave No Trace education on environmentally responsible behaviors in outdoor recreation settings as well as at home/in local communities?

LEAVE NO TRACE AND WELL-BEING

Countless studies have documented the connection between ecological and social well-being (e.g., Schlueter et al., 2012; Wu, 2013;) and we believe that Leave No Trace has and can continue playing a significant role in the health of nature and the influence of nature on human well-being. Amidst the COVID-19 Pandemic, numerous studies have noted the increased need for nature engagement for human health and well-being. For example, Rice et al. (2020) noted discrepancies in access to nature and associated health ramifications amidst the pandemic. Other studies have documented that the increase in outdoor recreation amidst the pandemic has been largely driven by individuals seeking the health benefits associated with nature and outdoor recreation (Mateer et al., 2021). To date, one study has noted that ecological impacts decreased human affect and stimulated negative emotions, whereas more pristine trail systems and overlooks promoted more positive emotional responses (Taff et al., 2019). Collectively, these studies suggest that Leave No Trace may play a role in human health and well-being, which merits additional exploration.

▶ **Why are these studies important for Leave No Trace?**

Ecological well-being is vital to sustaining human well-being, and preliminary research suggests that Leave No Trace can aid with the sustained health of this coupled system. Further understanding the role of Leave No Trace and well-being will enable our organization to engage with different partners and increase our efforts to sustain nature and the benefits of nature for all.

▶ **Within this priority, example research themes and related questions include...**

- How do ecological impacts (e.g., social trail, tree damage, denuded soil) influence a variety of human health measures (e.g., physiological and psychological)?
- Does Leave No Trace education improve visitor experiences (particularly through health-related measures) compared to those who do not participate in Leave No Trace education?

CITIZEN AND COMMUNITY SCIENCE MONITORING

Park and protected area land managers strive to protect natural resources and promote quality visitor experiences however, their fiscal constraints and staffing capacities are challenged by increased visitor demands. This provides great opportunities to implement citizen science projects. Citizen and Community Science offers a way for the public to engage in data collection while also aiding land managers and the scientific community with monitoring data. Recreation ecology research, examining the ecological impacts associated with recreation (e.g., Marion et al., 2016), provides the potential for citizens to track impacts on natural and cultural resources, which can offer meaningful monitoring data that can be evaluated for trends longitudinally. Leave No Trace has recently engaged with several land managing agencies, such as the Bureau of Land Management, to facilitate Citizen and Community Science projects; data indicate that individuals involved with Leave No Trace participate in more environmentally responsible behaviors more frequently than the general public, indicating that our programming and our constituency may be the ideal citizen scientist community. Furthermore, once Leave No Trace practices are implemented at a particular location, citizen and community science monitoring enables the ability to track potential changes to the ecological and social conditions in the area.

► Why are these studies important for Leave No Trace?

Understanding how Leave No Trace can promote and facilitate Citizen and Community Science, and the role of changing technology (e.g., applications, etc.) in enabling data collection is of importance for the Leave No Trace organization. Furthermore, monitoring trends over time, particularly pre-post Leave No Trace implementation, is of value to our organization. These data can longitudinally inform adaptive management, as well as our training and programming efforts.

► Within this priority, example research themes and related questions include...

- What are the longitudinal effects of Leave No Trace education/implementation, and how can those be monitored through citizen science efforts?
- What types of ecological monitoring can feasibly be collected longitudinally (e.g., trail widening, tree damage, food/human waste sites, holes dug up) through citizen science efforts?
- What types of social science (e.g., observations, descriptive counts) can feasibly be collected longitudinally through citizen science efforts?



Figure 9. Researchers use app to collect recreation ecology data at Grand Staircase-Escalante National Monument.

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