WILDERNESS AT RISK: SOCIAL IMPACTS OF DISCARDED USED TOILET PAPER

Elli Morris

A Professional Paper

Submitted in Partial Fulfilment of the

Requirements for the Degree of Master of Forestry

Northern Arizona University

School of Forestry

May 2022

Advisor: Alark Saxena, Ph.D.

Readers: Catrin Edgeley, PhD., Yeon-Su Kim, PhD.

ABSTRACT

Designated wilderness areas in the United States are managed to be natural locations. During and after COVID-19, these lands experienced a marked increase in visitor numbers and saw an increase in human waste, litter, and discarded used toilet paper (DUTP). These types of pollution are reported problems for managers but is DUTP a problem for wilderness users? Does DUTP impact the purpose of wilderness? What causes people to pollute, particularly in remote wilderness locations? No research could be found on addressing DUTP as a separate concern from human waste or litter, on impacts hikers experience when seeing DUTP, on the use of the knowledge, attitudes, and practices (KAP) research framework for wilderness issues, nor have baselines of existing quantities of DUTP been established. The objectives of this research are two-fold: 1) To understand wilderness visitor KAP toward DUTP in wilderness areas. 2) Develop baselines of DUTP in wilderness. This form of inquiry addresses implications DUTP may have on the purpose of wilderness areas and help determine if there is a need for urgent action. Results highlight that 1) management and scientific approach of grouping DUTP with human waste or litter fails to address the unique impact DUTP has on hikers and the purpose of wilderness areas, 2) new language, content, placement, and timing of information are needed to improve compliance with management desires for wilderness users to pack out their used toilet paper; 3) the KAP framework identified social constructs that lead to hiker behavior and identified context specific solutions; and 4) unbeknownst to visitors, their tolerance levels towards DUTP have already been breached. Combining KAP surveys with spatial analysis reveals an urgency for wilderness stakeholders to directly address DUTP as the purpose of federally mandated wilderness areas is at risk.

ACKNOWLEDGEMENTS

Gratitude is as an insufficient term to express the gifts of support, encouragement, direction, guidance, and patience my advisor, Dr. Alark Saxena, has showered on me. His family has boosted my morale in times of need. Doctor Catrin Edgeley deserves much praise for her openness toward my requests for guidance and direction, which she followed with an outpouring of constructive and supportive feedback as I meandered my way through grad school. Many thanks to Dr. Yeon-Su Kim for her willingness to share her profound knowledge and patiently guide me step by step, even after she moved out of her role as professor and on to being Interim Executive Director of the School of Forestry. Deep appreciation goes to the Krimminger family for their generous financial support from the C. R. Krimminger Forestry Scholarship. The acceptance of all the NAU staff and faculty surpassed all expectations of being accepted as a quirky 60-year-old grad student. Thanks, Bruce Foxx, for sticking with me through the many email exchanges and convincing me to check out NAU and thank you, Rich Hofstetter, for so naturally making me feel at home in the halls of the School of Forestry. I'm grateful for the welcoming acceptance by my fellow forestry cohorts, ever more sweet due to its absence from COVID-19 isolation during my first year at NAU. My sisters, Marcee Silver and Ellen Morris Prewitt, along with friend Gayle Wright, have helped maintain my sanity and enabled me to continue pursuing this endeavor to its completion. The generosity of Ellen and her husband, my brother-in-law, Tom Prewitt, exemplifies their faith in me and magically removed years of future financial stress. Last but not least, I am so very thankful and humbled by the survey respondents who trusted me to honor their input and identify solutions to an issue near and dear to each of their hearts, discredit used toilet paper in wilderness areas.

Table of Contents

List of Figures, Boxes, and Tables

Supplemental Figures and Tables

Wilderness at Risk: Introduction

The health benefits of nature can be experienced in congressionally designated wilderness areas (Bratman et al., 2021; White et al., 2019). During COVID-19 wilderness managers expressed concerns about increased quantities of discarded used toilet paper (DUTP), but it is unknown if this type of litter is a problem for wilderness visitors (Kyle & Brady, 2020; Meikl, 2022). Wilderness areas are managed to provide pristine and natural conditions for enjoyment by the American public (Hill, 2017; The Wilderness Act, 1964). If unaddressed, quantities of DUTP are likely to increase because visitor user numbers are expected to increase, which often results in increases in pollution (Cole et al., 1987; Warren, 2020). Understanding the impacts hikers experience from seeing DUTP may have implications for management mandates and educational outreach efforts (Hill, 2017). Understanding the root causes that lead to this type of litter can identify solutions to decrease DUTP quantities in wilderness (Rav-Marathe et al., 2016). Knowing how much DUTP exists in wilderness is necessary to inform successful management policies and actions (Hill, 2017).

No research could be found on DUTP, on impacts wilderness users experience seeing DUTP, on wilderness visitor practices toward pollution in general, nor on existing quantities of DUTP. Rather than directly addressing DUTP, prior scientific research and wilderness stewardship educational campaigns have examined impacts of "human waste and toilet paper," "litter, including toilet paper**"** or litter is not defined. (Hall & Cole, 2007; Wallace et al., 2004; Weaver, 2013) To assess the various issues that negatively impact user experiences, research has relied on examining wilderness user knowledge and attitudes, but none could be found incorporating wilderness user practices. Should wilderness managers desire to monitor DUTP,

no baseline densities nor frequencies exist as quantifiable references for future policy effectiveness. This research addresses the pollution information gap by asking wilderness hikers their knowledge, attitudes, and practices (KAP) toward DUTP. The KAP research framework provides a more complete representation of human engagement with wilderness and can identify possible solutions to DUTP in wilderness areas. A novel spatial data research method, which addresses the lack of measurable indicators on DUTP, was designed to aid management in determining if an urgency exists and in evaluating the effectiveness of intervention campaigns. Understanding why people pollute wilderness areas can help managers and wilderness advocates provide the variety of positive experiences sought by wilderness users and as intended by Congress.

The structure of this paper is divided into four sections. The first section is a literature review of wilderness management mandates and protocol addressing pollution, prior research on wilderness user impacts from pollution, and how the KAP theoretical framework has been deployed for greater understanding of environmental issues. The second section outlines the methods used for the semi-structured KAP survey and spatial data collection process conducted in four designated wildernesses in three western US states. The third section presents the research results identifying negative impacts respondents experience from seeing DUTP and revealing the quantifiable amounts of DUTP found in the surveyed wilderness locations. The final section discusses the urgency for management, nonprofits, and the outdoor and tourism industries to address the quantity and construct problems leading to DUTP, which negatively impact wilderness character and threaten the purpose of designated wilderness areas.

1. Literature Review

1.1 Wilderness Management and Protocol

The medical community, outdoor recreation, and tourism industries have actively promoted the health benefits of engaging with nature, which include decreased probabilities of mental stress, improved blood pressure, and general well-being (Bratman et al., 2021; White et al., 2019). Congressionally designated wilderness areas are desirable locations to experience these benefits (Bratman et al., 2021). The Wilderness Act of 1964 established Wilderness areas, federally designated locations set aside for the enjoyment and use by the American public (The Wilderness Act, 1964). These federally designated areas are managed to be on the extreme end of pristine, for their naturalness, and with the "imprint of man's work substantially unnoticed" (Hawken & Granoff, 2010; The Wilderness Act, 1964). Wilderness designation also has a contested history (Cronon, 1996). Terms used in the policy, such as *natural* and *primitive*, set up a human nature divide that obliterates Native American's history and engagement with the land. Although wilderness areas are open to the public, the rules and regulations, such as nonmotorized travel, can exclude access. Wildernesses provide ecosystem services, recreation opportunities, and are valuable assets to local and regional economies with the estimated economic impact of wilderness areas over $700 million nationally (Hjerpe, 2018). During COVID-19, wilderness and dispersed recreation areas experienced a 75% increase in visitation (Avitt, 2021). Visitors were a mixture of seasoned users and first-time visitors without educational awareness of their environmental impacts (Sevigny, 2020; Taff et al., 2021). These increases in visitation numbers add to the pressure of overcrowding and human pollution (Rudzitis, 2000). As more people engage with wilderness areas it is imperative that these areas be managed to

provide positive experiences for wilderness users and businesses dependent on those positive experiences.

The Wilderness Act created the National Wilderness Preservation System (NWPS) and established legal management mandates, with monitoring indicators a critical aspect of quantifying compliance. For example, the US Forest Service relies on Recreation Opportunity Spectrum (ROS) and Wilderness Stewardship Performance (WSP) management frameworks (Landres et al., 2012). WSP monitors biological impacts, but DUTP can impact two of the three ROS setting components, "Evidence of Humans" and "Visitor Density." When monitoring for wilderness character, DUTP is not a separate indicator and is not mentioned with litter nor with human waste indicators (Cole & Hall, 2009; Manning & Lime, 2000). Existing quantities of DUTP are needed to monitor changes ensuing from new policies or expanded communication efforts, especially if controversial user restrictions are recommended (*Visitor Use Management*, n.d.). Wilderness managers also deploy educational tactics to share information about rules and regulations to help ensure areas maintain the four aspects of wilderness character (natural, solitude or a primitive and unconfined type of recreation, undeveloped, and untrammeled, (Landres et al., 2012)). All four of the federal agencies that oversee wilderness areas (US Department of Agriculture Forest Service (USFS), and the Department of Interior's National Park Service, Fish and Wildlife Service, and Bureau of Land Management) rely on Leave No Trace (LNT) principles as the standard sustainable approach for wilderness user engagement (Griffin, 2018). In addressing litter and human waste, LNT provides the broad generalization to "dispose of waste properly" but does not specifically address toilet paper. Locations for posting LNT principles include announcements on trailhead signs, on the back of self-issuing permit

registration forms (Supplemental Fig. S1), official agency websites, and more frequently, on agencies social media sites. Within the USFS, discretion on issue emphasis is delegated to the National Forest District Ranger. For example, Mt Evans Wilderness is located within Pike and Roosevelt National Forests. On the Wilderness Regulations page of the Pike National Forest website for Mt Evans Wilderness, the section on waste clearly states to pack out used toilet paper. The Roosevelt National Forest website section on Mt Evans Wilderness does not address toilet paper, litter, nor human waste.

1.2 Human Waste and Litter in Wilderness

In contrast to the positive benefits of engaging with wilderness areas, visitors also report negative impacts from encountering environmental degradation. Encountering pollution is in direct contrast to their expectation of visiting landscapes where the evidence of humanity is largely unseen (Muth & Clark, 1978). Pollution, including litter and human waste, can be defined as a physical (ecological) concern or a perceived (social impact) concern. Prior social impact studies on wilderness issues have asked users their knowledge and attitudes toward overcrowding, human noise from radios and cell phones, seeing other visitors feeding wildlife, dogs off leash, human waste, and litter or general trash (Hall & Cole, 2007; Stewart et al., 2000). Overcrowding, human waste, and litter consistently rank among the highest impacts reported by wilderness users, but hikers have been shown to adapt to overcrowding (Cole & Williams, 2012; Hall & Cole, 2007). Wallace et al (2004) reported overcrowding was the highest-ranking impact and "seeing human waste and toilet paper" was stated by 97% as one of the top three unacceptable issues.

For over 50 years, scientific research has documented litter in wilderness as a wilderness user concern (Cole & Williams, 2012; Lime, 1972), it has described litter as the most common avoidable and potentially simplest impact to manage (Leung & Marion, 2000), and yet during the COVID-19 pandemic, litter and human waste were the behavioral choices that contributed to the most impact for management (Kyle & Brady, 2020). The unacceptable levels of litter, human waste, and DUTP caused management to close areas and caused concerns for wildlife and the environment, but no research was found on impacts wilderness users experience from seeing DUTP (Cilimburg et al., 2000). Rather, as is done with management monitoring protocol, when scientific research includes the topic of toilet paper it is grouped either with litter or with human waste (see Cilimburg et al., 2000; Hall & Cole, 2007; Wallace et al., 2004). Incorrectly amalgamating DUTP with litter, due to its potential to be a source of negative health impacts for wilderness users, or with human waste, due to its high visibility, contributes to the scant information on proper disposal of used toilet paper in wilderness (Cilimburg et al., 2000). However, DUTP elicits a unique specific response as suggested by the anecdotal evidence from USFS Wilderness Rangers, wilderness managers, and wilderness users (B. Banks, personal communication, June 11, 2021; J. Rainey, personal communication, March 11, 2021). DUTP needs to be addressed separately and in a timely manner. Wilderness visitor numbers are expected to continue increasing and increases in visitor numbers have been associated with increased quantities of pollution (Cole et al., 1987; Warren, 2020). Understanding hiker impacts toward DUTP is needed to identify potential ways to solve this type of litter and to support land manager policy changes.

1.3 KAP Research Framework

KAP is a research framework which uses surveys to understand and measure what individuals know about a specific problem. The methodology was developed in the 1950s to identify gaps between medical patient knowledge, attitudes, and preventative practices about family planning (Launiala, 2009). The theoretical foundation of the KAP framework is that knowledge forms attitude, and that both knowledge and attitude inform practices (Ahmad et al., 2015). Historically, KAP has been used in the health field (Launiala, 2009), medical field (Fan et al., 2018), education field (Goutille, 2009), community development (IIDS, 2006) and environmental and ecotourism fields (see Kiran et al., 2015; Rawlins et al., 2007; Saxena et al., 2018).

KAP surveys have been used for novel issues to identify baseline understanding (Andrade et al., 2020). Although not all KAP surveys identify a strong correlation between knowledge and practices (see Ahmad et al., 2015; Ehrampoush, 2005; Tikka et al., 2000), deploying this research framework for DUTP can deepen our comprehension and provide root causes of why practices may fail to align with knowledge and attitudes (Gopaul et al., 2016; Rav-Marathe et al., 2016, p.). These findings can provide valuable information for the development and implementation of effective educational outreach campaigns (Ahmad et al., 2015; SPRING, 2014). Moreover, educational campaigns based on information gleaned from KAP surveys have been shown to effectively result in behavioral change (Rav-Marathe et al., 2016). The KAP framework recontextualizes individual actions into the larger context of cultural constructs that inform individual behavior (Hargreaves, 2011). Reframing the DUTP conversation away from the symptoms of toilet paper and toward the constructs that lead to

this practice in wilderness areas can identify barriers toward compliance. These three components of human behavior, knowledge, attitudes, and practices, can provide a more complete representation of human engagement with wilderness areas to facilitate improved stewardship practices.

No research was found where the KAP framework was used for wilderness issues. Prior research surveys have asked about knowledge and attitudes, but none were found incorporating survey questions on practices toward negative impacts in wildernesses. No research was found specifically asking visitors how observing DUTP in wilderness affects their visitor experience nor was any research was found examining DUTP as a unique and separate concern. This research aims to apply the KAP methodology in a novel way to build on the scientific understanding of environmental issues. Asking hikers about their practices allows them to express their opinions, concerns, barriers, and needs. This bottom-up approach can lead to better management of wilderness areas (O'Connor et al., 2021). Coupling the bottom-up approach of KAP with the top-down approach of the Forest Service wilderness management system can lead to effective behavioral change for long lasting sustainable engagement with these protected lands.

1.4 Research Objectives

The objectives of this research are two-fold: 1) To understand wilderness visitor knowledge, attitudes, and practices (KAP) toward discarded used toilet paper (DUTP) in wilderness areas. 2) Develop baseline quantities of DUTP in wilderness areas. In tandem, examining root causes of this type of pollution will further understandings about why people

litter and quantify the need to implement identified solutions to improve efforts from government, nonprofit, educational, and tourism wilderness stakeholders to provide more sustainable engagement with nature.

2. METHODS

2.1 KAP Survey

The KAP framework is used to understand barriers to practices by assessing knowledge and attitudes. The KAP instrument can include quantitative and qualitative open-ended questions, making it a useful methodology for novel issues (Andrade et al., 2020). Survey questions can be adapted from prior surveys towards a variety of diverse topics. By looking beyond the symptoms of DUTP, KAP surveys examine the root causes which include social constructs that lead to behavioral practices around pollution. Adapting the KAP framework for DUTP can identify barriers to adherence of wilderness management policy and identify context-specific solutions. Surveys are administered to a sample of participants intended to be a representation of the target population (Andrade et al., 2020). By compassionately engaging with all stakeholders, the effective KAP bottom-up methodology can help land managers develop targeted marketing campaigns for DUTP and the larger issue of pollution in general.

2.1.1 Developing the KAP survey

Survey questions were pulled from existing surveys assessing wilderness visitor demographics and wilderness visitor knowledge and attitudes toward degradation issues in

wilderness. Questions on litter and human waste were adapted to assess impacts of seeing DUTP. Surveys ranking visitor impacts to degradation issues were incorporated to rank and compare DUTP to previously ranked issues. Themes and categories were developed in consultation with a KAP researcher who had deployed this method for other environmental issues. Additional questions were based on feedback from wilderness managers, National Forest District Rangers, and from the marketing department of LNT. The survey questions were then workshopped with a panel of wilderness users, wilderness management employees, and environmental outdoor educators. The 57-question survey has seven thematic categories (Fig. S2) seeking visitor information, wilderness and area visitation, relationship to nature, preparedness, impression of landscape, and future/solutions. The survey was open to wilderness visitors 18 years of age and older and estimated to take approximately 20 to 25 minutes to complete. The survey was designed as an in-person exit survey, to be conducted at trailheads as visitors exited the wilderness, enabling immediate capture of visitor responses to potentially seeing DUTP. Survey questions were administered orally and a laminated bound printout of survey questions was offered for survey respondents to follow along and/or simply provide answers. Respondent answers were handwritten in pen on a notepad. The term *toilet paper* was defined as any material brought into the wilderness to be used for defecation and urination hygiene.

2.1.2 Locations and Recruitment

Survey locations were constrained to wilderness areas managed by the USFS for consistency of management protocol. Survey sites were selected for similarities of topography and climatic

conditions for more consistent wilderness user experiences and DUTP decay rates. To better assess if this problem was local or on a larger scale, wilderness areas were selected from different USFS regions. USFS Regions 2, 3, and 4 were selected (Fig. S3) as these have similar and numerous arid mountain wilderness areas. Selected locations had reported problems with DUTP along the trail and/or at campsites (B. Banks, personal communication, June 11, 2021; P. Dawson, personal communication, September 24, 2021; S. Kranz, personal communication, April 9, 2021; M. Scott, personal communication, August 1, 2021). To identify any patterns related to KAP towards and quantities of DUTP, potential wilderness survey locations were selected based on distance from population centers, population sizes, ease of access, and characteristics of urban population. Three western states were selected (Arizona, Colorado, and Idaho) and six high-visitation trailheads were selected for the greatest chance of representation of the target group. To accommodate wilderness management permission, which required surveys to be conducted outside of wilderness areas, surveys were conducted at trailheads leading into wilderness areas. To recruit stakeholder engagement, an 8 x 10 flier was placed beside survey administrator at the setup location and visitors were verbally asked to participate. Set up was positioned in line of sight as visitors exited the wilderness. Surveys were conducted in Colorado and Idaho during July and August, 2021, the peak summer tourist season, and in Arizona during October, 2021, the peak fall foliage tourist season. Surveys were conducted on a weekend day for highest user visits with a minimum of eight hours spent waiting for hikers to exit wilderness areas. Wilderness areas identified as study sites for this research are described below.

Kachina Peaks Wilderness (KPW), located in the Coconino National Forest in Arizona is in USFS Region 3. Humphreys Peak Trail #151 is a 20-minute drive from downtown Flagstaff, an outdoor-oriented small city with a median population of 76, 831 (*World Population Review. Flagstaff, Arizona Population 2022*, n.d.).

The two wildernesses in USFS Region 2 are in the Pike National Forest, situated in the Front Range mountains of Colorado. Both trailheads are within a two-hour drive from Denver, one of the largest metropolitan areas in the western US. Access to Goose Creek Trail #612 in Lost Creek Wilderness (LCW) requires driving 22 miles on gravel roads whereas Abyss Lake Trail #602 in Mt Evans Wilderness (MEW) is directly off Guanella Pass, a Colorado Scenic Byway.

Sawtooth Wilderness (SW), located in the Sawtooth National Forest in Idaho, is in USFS Region 4. The nearest town to the Sawtooth Wilderness is Stanley, Idaho, a remote tourist destination with an official population of 116 ("Stanley, Idaho," 2022). The nearest city of any size is Boise, population 235,684, a 3-hour drive on winding two-lane roads. Two of the three selected trailheads, Iron Creek #640 and Tin Cup Hiker trailhead are within a 15-minute drive from Stanley. Redfish Creek-Baron Creek Trail #101 is similarly close to Stanley but requires either a 5-mile hike or a 10-minute boat shuttle.

2.2 Spatial Data Collection

No prior research had been conducted on existing quantities of DUTP in wilderness, yet monitoring wilderness conditions is a critical tool used by USFS management to ascertain wilderness character. Baselines are needed to evaluate the effectiveness of policies and protocol. Moreover, baselines can determine if an urgency exists to address this particular type

of pollution in wilderness areas. Additionally, spatial data references are useful to compare to respondent reported quantities.

2.2.1 Survey Technique

Wilderness campsites are user-defined, often scattered across the landscape, and difficult to predict. To account for this variability, a robust systematic approach was developed in consultation with a GIS expert from Northern Arizona University. As no predetermined grid pattern could be established for data collection, randomization was deployed. Once a campsite was identified, by following unofficial social trails, a US quarter was flipped to determine if the campsite would be surveyed or not. A campsite was defined by a fire ring and suitable flat sleeping location or barren ground that showed repeated tent use. The Avenza Maps app, which records GPS satellite data, was used to mark and photograph each campsite center. For surveyed sites, any DUTP within approximately 150-foot radius from the campsite center was marked and photographed. The survey radius was adapted based on the universal need among hikers for relatively flat and private locations for defecation and urination. As such, suitable locations are often associated with numerous campsites. Rather than counting individual pieces of toilet paper, clumps of toilet paper were counted as one incident. If several clumps of toilet paper existed within a 2-foot area, that was counted as one incidence. As with the KAP survey, toilet paper was defined as any material brought into the wilderness to be used for personal hygiene, which included tampons, feminine pads, and diapers. Items had to be visible; no rocks were overturned, and no piles were dug up. Spatial data was conducted on the Monday

following the associated weekend survey to minimize discrepancies between what survey respondents noted having seen and quantities identified on the landscape.

2.2.2 Camping Destination Locations

Although wilderness areas do not have designated camping areas, the steep rocky mountainous conditions of the wilderness areas surveyed tend to have limited favorable conditions that receive repeat visitor use. Five popular and heavily used camping destinations were identified from wilderness management input along with respondent input as to where they had camped. The five locations surveyed are: Helms Lake in MEW, 6 miles from Abyss Lake trailhead; along Goose Creek and by the historic buildings in LCW, four miles from the Goose Creek trailhead; Alice Lake in SW, 5.5 miles from Tin Cup Hiker trailhead; Alpine Lake in SW, 6.9 miles from Redfish Inlet boat drop-off; and Sawtooth Lake in SW, 5 miles from the Iron Creek trailhead. No spatial data was collected in the KPW as the wilderness area is a day-use location.

3. Results

In KPW, 16 questionnaires were completed, 27 at LCW, 25 at MEW, and 42 at SW for a total of 110 questionnaires. Of the 118 campsites found, 12 were surveyed in LCW, 19 in MEW, and 31 were surveyed in SW, for a total surveyed campsites of 62; the remainder were removed by the randomization process.

3.1 Respondent Characteristics

Demographics of respondents completing the survey differ slightly from the USFS National Visitor Use Monitoring (NVUM) 2016-2020 data (*NRM NVUM Results*, n.d.). DUTP survey results are 44.9% Female, 55.1% Male and NVUM are 51.2% and 48.8%, respectively. Age brackets do not align perfectly, with the DUTP survey using 18-24 and NVUM using 20-29, but the largest percent of visitors in the survey were in the 25-34 age bracket, at 42.7% of respondents, while the NVUM is the 60-69 age bracket at 21%. It should be noted that the statics for NVUM are computed by expanding samples to wilderness population visits and include all wildernesses within the selected National Forest, not exclusively the wilderness areas surveyed. Respondent economic investment in their trip varied based on the distance to the wilderness from their home base. Respondents in the two Colorado wilderness areas were all residents with zip codes in the Denver metropolis area, within a 2-hour drive, with one exception being a visitor from the northeastern US. In MEW, 52.9% of respondents visited a local store while 50% did so from LCW. In KPW, a 20-minute drive from Flagstaff, only 19% of respondents were locals with 75% of all respondents stating they visited a local business. In SW, where 100% of respondents lived more than an hour away, 84% of respondents visited local businesses. Average budgets for respondents' trip were $541 in KPW, $173 in MEW, $112 in LCW, and $1038 in SW, reflecting the destination nature of this wilderness area. Most (70.1%) respondents were on a single destination trip, just to the one wilderness. Respondents were fairly split between day use, 46.7%, and backpackers, 30.8% overnight and 22.4% on a multiday trip, n=107. Slightly more than half, 59.8%, of respondents reported visiting the specific wilderness for the first time, with 19.6% visiting two to three times.

3.2 Respondent KAP toward DUTP

Questions asked in the research KAP survey do not reflect specific isolated concepts and can overlap. For clarity, the results are gathered into categories as seems most appropriate.

3.2.1 Knowledge

Management desires at all four surveyed wilderness areas is for visitors to pack out their used toilet paper. However, 77.4% of respondents stated they read no signs specifically stating to pack out their used toilet paper (Fig. 1). Only one respondent in MEW reported seeing a notice about toilet paper and that was from a hiker post on a trail app. One respondent in SW stated having learned about the pack out policy on a phone call to the Stanley Ranger Station and one respondent in KPW noted they learned to pack out their used toilet paper from the volunteer stationed at the Humphrey's Peak trailhead. Two of the 26 respondents at LCW stated they saw signs at the trailhead, but these signs only stated to dispose of waste properly, no mention of toilet paper existed.

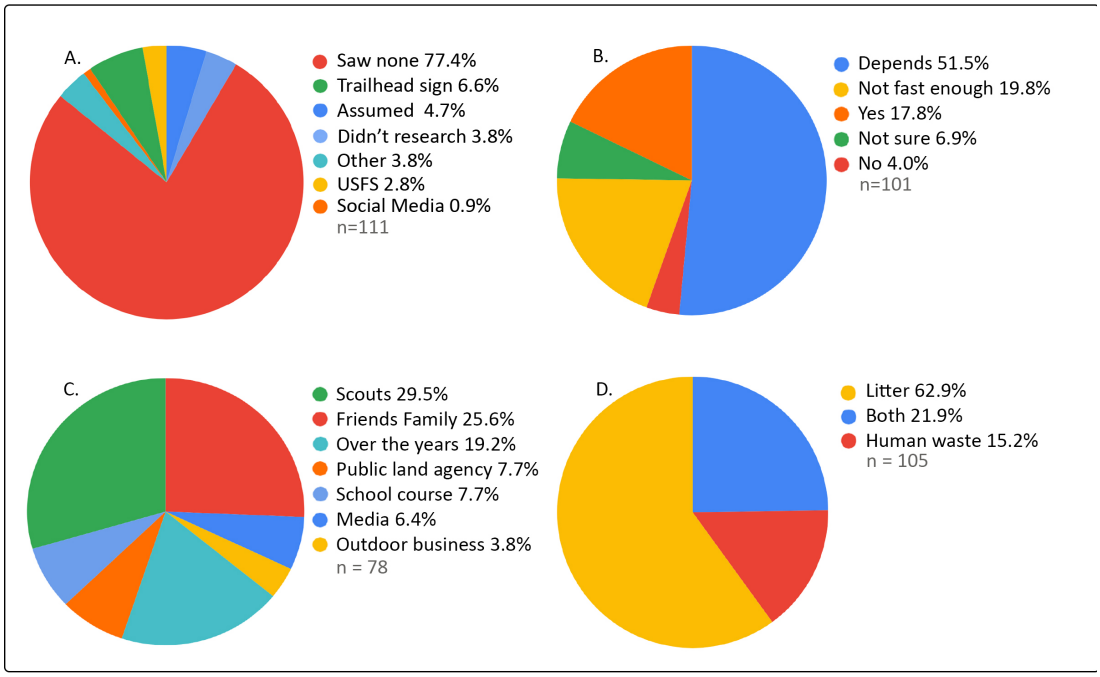


Fig. 1. Respondent knowledge toward DUTP.

A) Did you see any information specifically addressing packing out your used toilet paper? B) Is toilet paper biodegradable? C) Where did you learn your outdoor ethic? D) Do you consider DUTP litter or human waste?

About half (51.55%) of respondents stated toilet paper may be biodegradable but it depends on chemicals in the product, the printed design, and landscape conditions (Fig. 1). As Respondent TC4A noted, "I thought yes, but I guess it depends on the chemicals now that I'm thinking about it." For 19.8% of respondents, toilet paper cannot biodegrade as fast as it is being left or before animals get into it. Only 4.0% of respondents stated no, toilet paper is not biodegradable. Four respondents noted they purchased expensive biodegradable toilet paper at a national outdoor gear store because it was promoted as a viable option even though leaving toilet paper goes against the wilderness practice of packing out all used toilet paper.

The three main categories where respondents stated learning their outdoor ethic are Scouts (29.5%), Friends and Family (25.6%), and Over the Years (19.2%) with educational

institutions, public land agencies, and media each under 10%. All respondents stated they have an outdoor ethic.

The most difficult question for respondents to answer was determining if DUTP was human waste or litter (Fig. 1). When the questionnaire was administered to a group, they often debated the question among themselves. Respondent IC5A summed up the dilemma stating, "Litter, I guess. It depends. That's a tough one." When respondents couldn't make a choice, they opted for "Both" even though this was not an option presented on the survey.

A. **Gross Gross Gross Gross Gross Gross Gross Gross**

Disappointing	Disgusting
Hate seeing it	Discourages exploration
Laziness	Reservation of cleanliness
Ruins trip	I won't pick it up
Irresponsible	Ought to know better
Disrespectful	Dog gets in it

No respect for environment
Takes away from wilderness experience
Invasion on solitude - reminder of other people
Doesn't feel like nature anymore
Bothers me people don't follow the rules

B. **A bag seems gross Has poop on it, gross Bury it - it's gross**

Don't do it - Burn it	Specific container to mask scent
Don't want to pack it out	Something specific for leakage
Gets on hands	Remembering clean and dirty bag
Mental discomfort	Remembering ziplock bag
It is annoying	No habit, thought unnecessary
Does it go in the bear bag	Finding room in pack not by food

Not know what to do with it especially when not prepared
One more thing to carry but not a big deal
No challenge, have a system it's great
Put all trash in one bag
It was a short day hike, take out with other trash

C. **Normalize it Normalize it Talk about it**

Notice at trailhead	Biodegradable and leak-proofness
Sign would help	Dedicated doggie bag
If I was told to	Human doggie bag
Have it be known	Accessible trashcan at trail head
Rubber gloves, bag	Packs of TP with double zip baggies
Easier products	Not have to take home in car

Product specifically made for that purpose
Access to products at grocery store
Know dogs are really bad but don't know human impact
If has impact on environment, be good to know
Know the impacts especially social/bio

D. **Education Education Education Education Education**

Signs like for bears	Supply containers at trailhead
A links to effects	Recognition it's a problem
Better marketing	Handy cool product
Toilet at trailhead	Trowels in bear boxes
Pictures at trailhead	USFS office have WAG bags
Get creative	Support from outdoor agencies

A video on how to use a toilet kit
Talk directly about it. Topic is glossed over
Communicate through common media
Reminder on apps like AllTrails, hiking project
Options for not bringing it out even to trail

Fig. 2. Quotes from respondents showing attitudes and practices toward DUTP.

A) Please describe the impact of seeing DUTP. B) What challenges do you face with packing out your used toilet paper? C) What would make you more likely to pack out your used toilet paper? D) What solutions do you have for decreasing quantities of DUTP in wilderness areas?

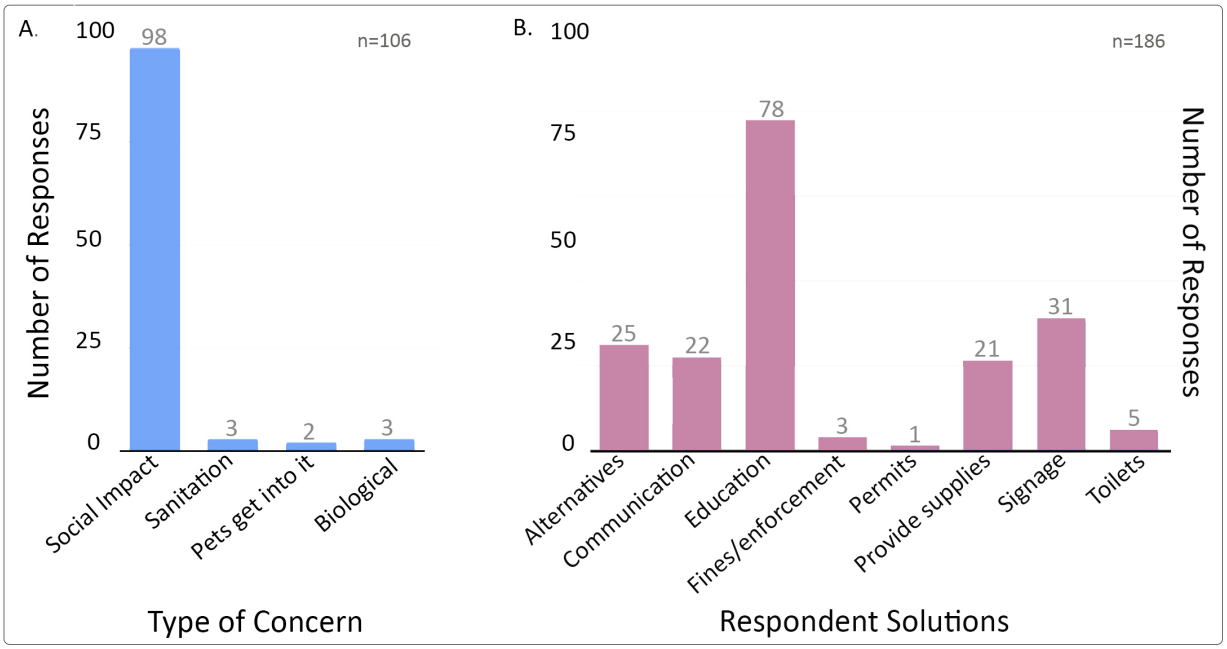


Fig. 3. Impacts experienced from seeing DUTP and respondent solutions.

A) Respondents experienced an overwhelmingly social impact to seeing DUTP. B) Respondent solutions for not leaving DUTP in wilderness were primarily focused on education.

3.2.2 Attitude

Undeniably, respondents reported a negative emotional response to seeing DUTP in wilderness areas (Figs. 2, 3). Only 2.8% of respondents mentioned their concerns were about the biological impacts to wildlife or the ecosystem, the remainder expressing impacts from a personal point of view. Respondents used terms that reflect their personal concerns, including "worried my dog will get into it" and "when I go off trail, I step in it." Respondents used judgmental language toward others who had left their toilet paper. Respondent GC2A stated "It's self-righteous" and Respondent GC2B shared, "I think lesser of them and think they are lazy." Respondents expressed their frustration because DUTP takes away their opportunity to be good stewards. As Respondent GC3 stated, "People like to pick up litter, but know no one will do that with toilet paper. It's a disrespectful kind of litter." Even though 100% of respondents stated they had a

negative impact to seeing toilet paper, they were not in agreement on the impacts of DUTP. Respondent GC6 stated, "I can rationalize and understand toilet paper, the worst impact is seeing broken beer bottles" but Respondent GC7 stated, "It's the worst thing to come across, it's very annoying." Respondent GC12 observed, "It surprises me with all the effort put into backpacking and then to leave toilet paper right there." Seeing DUTP has negative impacts on wilderness character for 20.9% of respondents, exemplified by Respondent TC3C's statement, "Overall, the place is not so pristine, beautiful, and clean as I thought." Seeing DUTP can negatively impact the positive health benefits provided by nature, as evidenced by respondents' negative emotional responses, best stated by Respondent GC2A, "Makes me sad and brings back worries about the environmental crisis."

Respondents ranked their top impact generally in alignment with prior experiences (Table S1). Respondent IC4A selected "Human Noise" stating, "I've had more issues with noise" and Respondent AB7B selected general trash as their top impact with the caveat that "I've not experienced DUTP." When asked to rank the impact of seeing DUTP compared to impacts of overcrowding, a degradation historically assigned high ranking, respondents rated DUTP as more of a concern (Table S1). However, respondents repeatedly stated DUTP and overcrowding are difficult to separate. Respondent GC5b stated, "Overcrowding and DUTP go hand-in-hand" and Respondent HP5 noted, "There's a correlation with them, more DUTP means more people." Respondent RF8A had a different concern, stating, "DUTP is the biggest concern because then you know human waste is there." For respondents who had not experienced seeing much DUTP, these two impacts were not as closely tied. Respondent HP7A noted, "Overcrowding is a bigger impact, but if I saw DUTP, it might be different, and I would not return."

The average respondent threshold for not returning to an area because of seeing DUTP is 2.9 (Fig. 4). Reasons given for tolerance levels varied. When Respondent AB10C stated, “If I saw two incidences of DUTP I’d be weirded out” the three other members of the group chimed

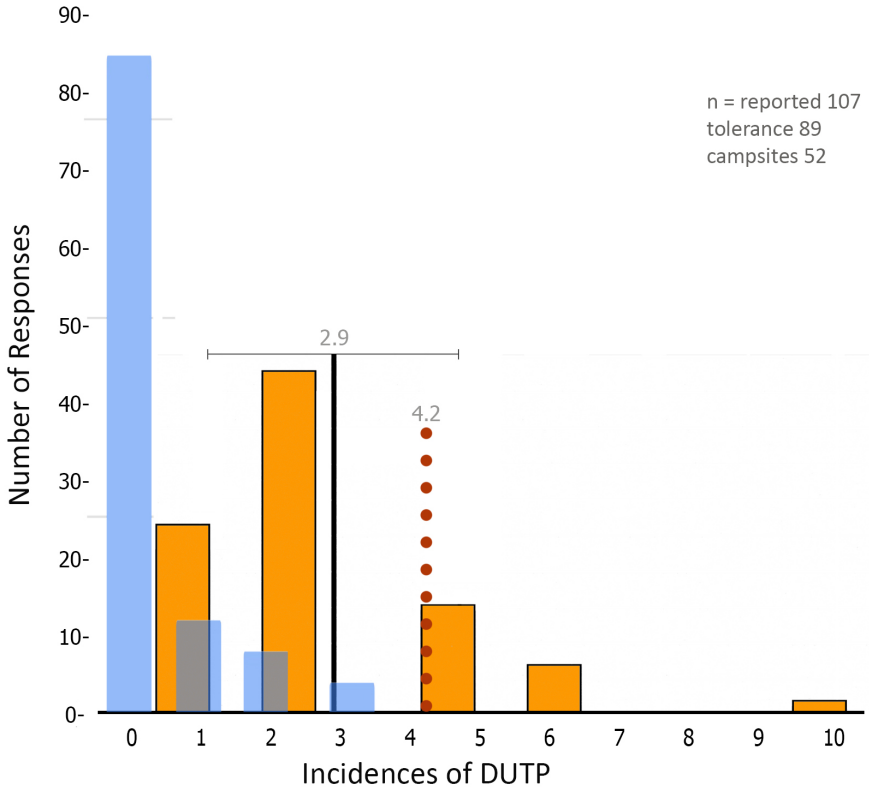


Fig. 4. DUTP quantities seen by respondents and stated thresholds compared to spatial analysis quantiles.

Respondent stated threshold for seeing DUTP that would terminate their return to the wilderness area has already been breached. Blue: No respondents reported seeing more than 3 incidences of DUTP, with 83 respondents seeing none; Gold: Respondent stated tolerance level for seeing DUTP, mean (2.9) and standard deviation represented by bar. Crimson dotted line shows spatial analysis average of 4.2 incidences of DUTP at campsites.

in with “Same.” Respondent IC4B stated, "DUTP is an indicator of overcrowding, and I won't go back."

3.2.3 Practices

Most respondents, 82.2%, were prepared to pack out their general trash. Respondents were less prepared to pack out their toilet paper, with 63% having a specific item, which varied from

plastic bag to Ziplock bag covered in duct tape to washable reusable bag to relying on dog bags. When asked if respondents had specific items for packing out their used toilet paper, the day hiker category respondents were not as prepared (54%) as overnight (65.6%) who were not as prepared as respondents in the multiday hiker category (79.2%). Respondent TC6A, a day hiker, stated, "This hike was a really short duration, so I didn't bring anything and didn't leave anything." However, regardless of the length of the wilderness trip, not all respondents knew to be prepared. When asked about specific items used to pack out their toilet paper, Respondent RF7A, who had been on a multiday trip, stated, “Is that something we’re supposed to do here in the wilderness? I didn’t realize that.” Alternatives to toilet paper were packed in or used by 20.6% of respondents, including pee rags, WAG (Waste Alleviation and Gelling) bags, and leaves. Of the 50 day-hiker respondents, 36% brought in toilet paper. Although overnight and multiday respondents brought in alternatives, only 3 of the 57 respondents in these two categories noted not bringing in any type of paper product.

Respondents reported facing numerous challenges with packing out their used toilet paper, concentrated around preparedness, sanitation such as leakage and where to put it in their backpack, and worries about smells (Figs. 2, 5). Respondent TC6B confessed, "I don't know what to do with it, especially when I'm not prepared." Respondent RF1C asked, "Does the used toilet paper bag need to go in a bear hang? How do I keep it separate from the food?" Respondent AB3A, stated, "Never done it. Seems gross. I don't have a habit. I thought it was unnecessary," while Respondent GC11C stated, "I have no challenge with it, I have a system and it's great." Respondents expressed a willingness to pack out their used toilet paper if barriers were directly addressed. Only 26.5% of respondents have altered their recreation choices in the

past due to seeing DUTP but for some, DUTP had no influence on returning to the area. Respondent TC4A stated, "DUTP has zero impact on returning to the area because I would still come here to visit family."

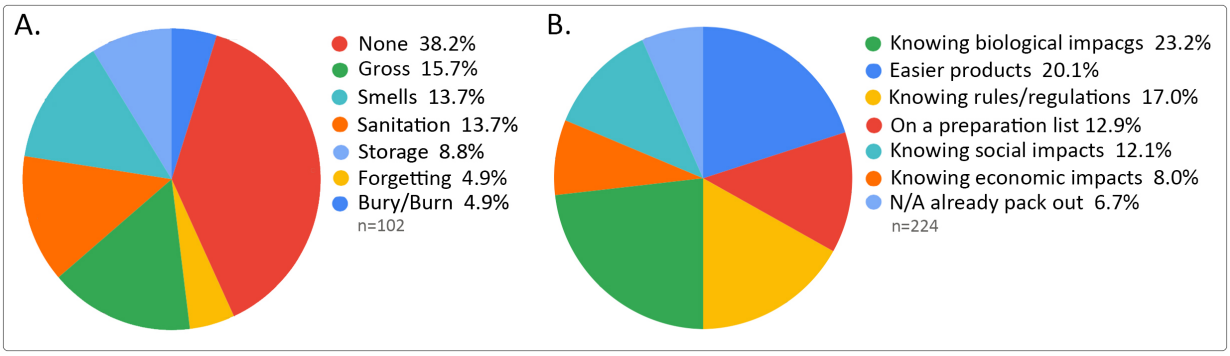


Fig. 5. Why do respondents not pack out their used toilet paper?

A) Challenges and barriers respondents have for not complying with a pack-out policy. B) Inputs that would make it more likely respondents would pack out their used toilet paper.

3.4 Respondent Solutions

Respondents recognized a need for a new approach to the conversation about used toilet paper in the wilderness (Fig. 2). Respondents overwhelmingly favorited education, 78%, as the solution for decreasing DUTP in wilderness (Fig. 3). Suggestions for topics to address include bringing awareness to the problem, including impacts to wildlife, the environment, and other hikers. Respondents suggested addressing biodegradability of toilet paper and incorporating regional decay rates so hikers could act more responsibly in specific areas. These were important concerns for respondents because they felt like many people think it's OK to leave their toilet paper in wilderness areas. Education also needs to help wilderness users know how to pack out their used toilet paper. Respondent GC2B suggested hikers can share knowledge

themselves stating, “Go on hikes with people who are not informed and teach them what to do.”

Changes in signage was the second most suggested solution by respondents (31%). Signs specifically stating to pack out used toilet paper need to be at the trailhead and on maps. Pictures rather than words should be used so hikers can quickly absorb the information because, as Respondent HP4 stated, "I came out to hike, not read."

Offering alternatives to toilet paper, changing the communication style, and providing supplies were the next top three categorical solutions, respectively 25%, 22%, and 21%. Respondents suggested discussing non-toilet paper options, sharing information about easier dedicated products, sharing agency-approved products at the trailhead, and putting an agency approval stamp on the packing of acceptable products. Communication style needs to normalize the conversation; there needs to be more creative and better marketing that takes advantage of websites, trail apps, and makes use of videos; and develop collaborative approaches such as working with other outdoor agencies including Departments of Natural Resources. These styles address the need for information to be, as Respondent AB7C noted, “readily available and prevalent.” Suggestions for supplies provided at the trailhead include designated disposal sites, trash cans, toilet paper kits, WAG bags, and porta potties. Other suggestions include having trash cans along the trail, WAG bags available at agency offices, and outdoor gear stores such as REI could give away toilet paper kits as customers exit the store. Only three respondents suggested fines, but they also recognized the difficulty of enforcement. Respondent RF8A offered hope stating, "We taught everyone to stop smoking and wear seatbelts so we can do this."

3.4 GIS Analysis

There was a significant discrepancy between how much DUTP respondents reported seeing, average of 0.4, and how much was documented during the spatial data collection, average of 4.1 per campsite (Fig. 4, Table 1). Respondents reported seeing DUTP at campsites and along the trails, but spatial data was exclusively conducted at camp sites. Of note are the summary statistics which show 84% of sites surveyed (n=62) had 1 or more incidences of DUTP (range = 26). Camping locations in the Sawtooth Wilderness had the greatest average of incidences of DUTP with a mean of 5. The two other wilderness areas had less than half that amount, LCW with 2.3 and MEW with only 2.1 per campsite. The high average in SW is heavily influenced by Alice Lake. This camping location had the greatest mean density of DUTP, 7.4 incidences per campsite. Campsite Alice Lake 12 had the highest density of all surveyed campsites, with 28 incidences of DUTP (Table 1, Fig. 6). Campsite Alice Lake 12 is a large site that can accommodate five to six tents. It is relatively flat, surrounded by dense groupings of trees on three sides, and the fourth side is protected by a long rock wall with multiple flat outcrops. Above and beyond the rock wall is a plateau with 15 to 20 of the most popular campsites because of the dramatic views of Alice Lake. These campsites are in an area sparse of trees, i.e., they lack privacy, and the soil is often quite shallow and rocky, i.e., it is difficult if not impossible to dig a cathole. Campsite Alice Lake 12 is the closest privacy location where wilderness users can dig a cat hole. These conditions can help explain why this campsite had the greatest concentration of DUTP of all campsites surveyed. At Alice Lake, the average distance of DUTP from the campsite center is 29.5 meters, reflecting the large size of Campsite 12 and the other group site, Campsite Alice Lake 3, whereas at Helms Lake in MEW the average is 17.1 meters.

Table 1. Spatial analysis results of DUTP in Colorado and Idaho along with examples of found DUTP.

Survey results from five campsite locations: GCC = Goose Creek, Loss Creek Wilderness; HLC = Helms Lake, Mt Evans Wilderness; CO = totals of these two Colorado locations. ALI1 = Alice Lake; ALI2 = Alpine Lake; SLI = Sawtooth Lake; ID = totals of these three Idaho locations. ALL = data from all 5 campsite area locations.

Survey Parameters	GCC	HLC	CO Total	ALI1	ALI2	SLI	ID Total	ALL Sites
Total number of campsites	22	26	51	25	18	25	68	118
Campsites surveyed w/ DUTP	6	16	22	15	5	10	30	52
Total incidences at campsites	15	14	29	104	6	29	139	168
Average DUTP/surveyed campsite	2.3	2.1	2.2	7.4	1.2	3.2	5	4.1
Range	4	4	0	27	1	6	26	26
Standard Deviation	1.5	1.5	1.4	6.8	0.4	2	5.5	4.8
Campsites surveyed no DUTP	6	3	9	0	0	1	1	10
Campsites not surveyed	13	7	20	10	12	14	36	56

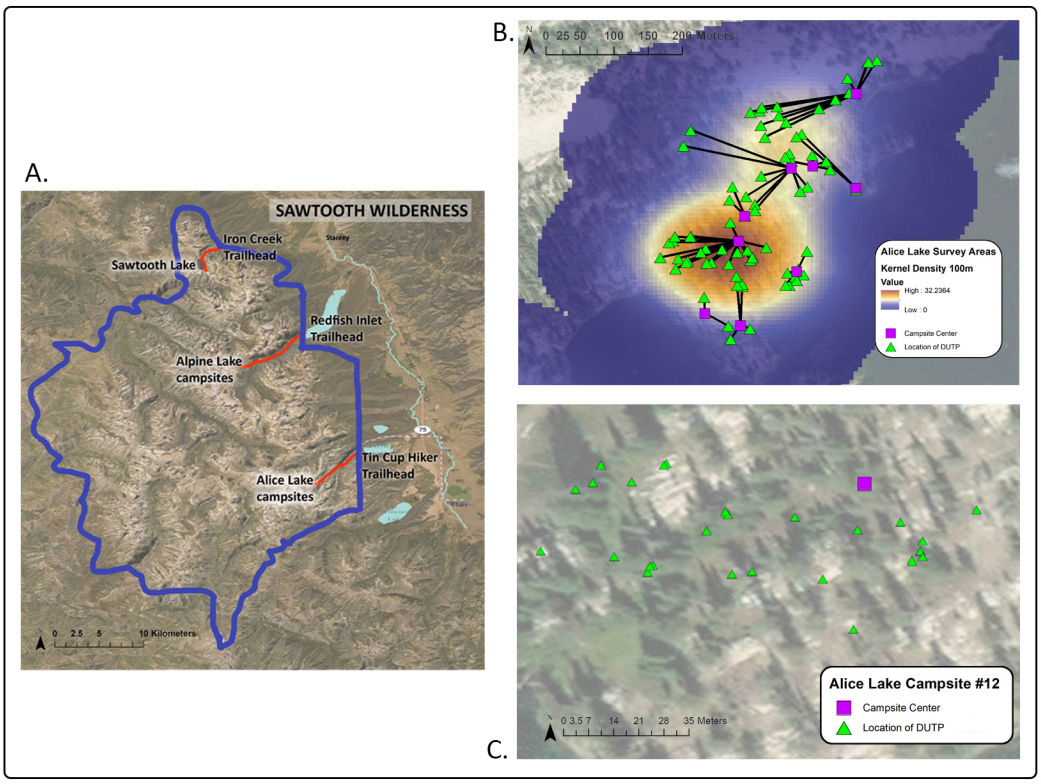


Fig. 6. Maps showing highest campsite density of DUTP.

The highest density of DUTP was documented at Campsite 12 at the Alice Lake camping location in Sawtooth Wilderness. A) Map of Sawtooth Wilderness. B). Heat map showing concentrations of DUTP at Alice Lake. C) Incidences of DUTP at Campsite 12.

3.5 Management Input

During phone calls and through email interaction, wilderness and public land mangers shared their frustration about seeing increased quantities of DUTP on the lands they manage. Their comments include, "It's definitely an issue," "You'll be measuring by the pound," "DUTP is a challenge for many protected areas," and "We are experiencing significant problems with DUTP in our area." These sentiments reflect the news stories about negative impacts from increased quantities of human waste, DUTP, and litter during COVID-19. Wilderness managers in MEW and LCW stated the data from the spatial analysis will be useful for management actions,

particularly that it can be used to show the need to implement permitting to reduce user impacts. Other public land managers noted the spatial data offers evidence of the extent of the problem, which is needed to request funding to address DUTP.

4. Discussion

Deploying the KAP framework combined with spatial analysis of DUTP in wilderness areas identified an emergency exists to address this pollution, which negatively impacts wilderness users and managers. As previously noted above, wilderness managers had expressed concerns about quantities of DUTP in wilderness but knowing impacts wilderness users experience adds to the immediacy and complexity of the problem. Management monitors ecological and physical indicators to assess wilderness conditions, yet the purpose of congressionally designated wilderness areas is for the enjoyment of the American public. This discrepancy is exemplified with DUTP. Although management concerns about the physical presence of pollution, in this case quantities of used toilet paper, were confirmed by the spatial analysis research, monitoring efforts alone fail to account for the full negative impacts DUTP has on user abilities to participate in these areas as intended by Congress. Three of the five qualities of wilderness character (natural, untrammeled, and outstanding opportunities for solitude) are at risk for 92% of hikers due to the social impact of seeing DUTP (Fig. 3). Without user input, educational efforts simply address the symptoms of litter rather than addressing social constructs that lead to the pollution. Deploying the KAP framework identified current management and outdoor advocacy constructs fail to incorporate wilderness user input and fail to address DUTP as a unique pollution (Fig. 7). Understanding these root causes is necessary for

more effective communication outreach campaigns addressing pollution issues threatening management mandates.

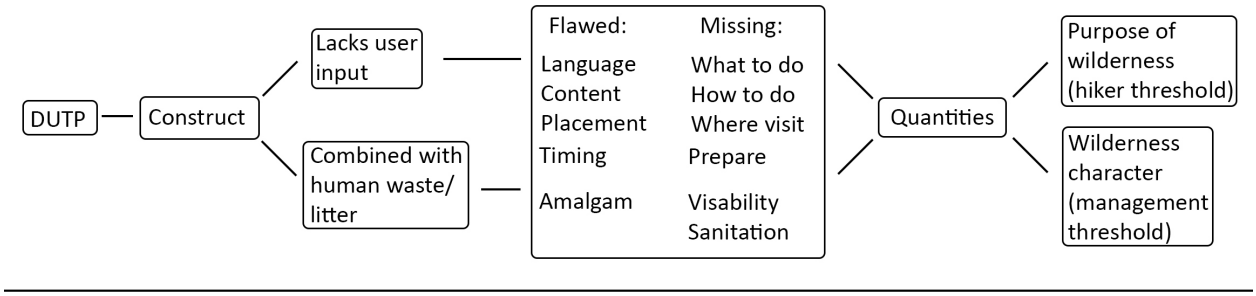


Fig. 7. Diagram of identified social constructs leading to DUTP.

Current system relies on social constructs that fail to incorporate wilderness user input and inaccurately addresses DUTP as litter or human waste.

4.1 Flawed Messaging

This research identified gaps in current messaging efforts which rely on social constructs that lead to root causes of why used toilet paper is left in wilderness areas. Messaging is flawed by vague language, content that fails to address user barriers, placement of information that doesn't reach visitors, and sharing rules and regulations too late for visitors to act on management desires to pack out used toilet paper. To have more effective educational efforts wilderness stakeholders need to incorporate wilderness user knowledge, attitudes, and practices towards DUTP as discussed below.

4.1.1 Language (Knowledge)

Not seeing stated desired wilderness protocol is a root cause of why visitors discard their used toilet paper in wilderness areas. Rather than directly talking about used toilet paper using

specific vocabulary, wilderness stakeholders rely on the social construct of vague and emotional language. These communication styles translate into respondents being unaware of rules and regulations, making incorrect assumptions about toilet paper disposal, relying on outdated knowledge regarding expectations, or being emotionally disturbed by the need to pack out their used toilet paper. These results align with prior on-site and mail-in surveys conducted by Stewart et al (2000) which identified hikers lacked understanding about proper disposal of toilet paper. Hikers, especially new hikers, do not have instinctual knowledge of what to do with their used toilet paper. Relying on the vague LNT term 'dispose of waste properly' assumes a more knowledgeable point of view than currently exists. This lack of inherent understanding coupled with broad generalized slogans is a potential cause of the uptick in DUTP during COVID-19, when new outdoor recreators represented 20.3% of increased visitation to public lands (Taff et al., 2021).

Direct language means not relying on the terms "gross" and "ickiest." Management practices, such as those at the Sawtooth Wilderness trailhead signs, and popular hiker magazines attempt to appeal to a sense of guilt and disgust to gain compliance and readability (Benner, 2015). However, not only does this approach not reflect respondents' desires to have the conversation and cultural attitudes about used toilet paper be normalized, but it may be counterproductive. Respondents used the word "gross" more than any other word to describe the impact of seeing DUTP (Fig. 2). Reinforcing this emotional response does not offer any useful knowledge or tools for wilderness users to comply with management desires. Knowing wilderness users desire to have the conversation normalized, that speaking directly about used toilet paper is not taboo, can support stakeholder educational campaigns efforts.

Beyond the language constructs is the tendency for hikers, particularly seasoned hikers, to simply not look at trailhead signs nor to conduct any research for their trip. Not reading signs or notices about current policies leads to outdated knowledge. Numerous respondents in the 45-55 age bracket stated they learned their outdoor ethic as children in Scouts, expressed not reading signs to update their knowledge and ethics, and felt confident that burning or burying used toilet paper keeps them compliant with wilderness protocol. Conversely, Pike National Forest Wilderness Managers stated a higher percentage of first-time hikers sign voluntary registration forms, and are more likely to read signs, than seasoned hikers (B. Mitchell, personal communication, February 24, 2022). Trailhead signs remain an advantageous location to share rules and regulations. However, given the potential lack of engagement with trailhead signs as a resource for wilderness management desires and the trend for higher visitor use in wilderness areas, and public lands in general, it is recommended that a unified pack out policy be adapted by the NWPS (Box 1). Adapting a unified policy would relieve the burden of wilderness users having to research rules and regulations for each individual wilderness area and could decrease costs associated with the current management practice of each wilderness area having its own policy toward packing out used toilet paper. Emulating the unified approach of relying on LNT protocol, the four wilderness management agencies could jointly adapt a pack-out policy.

Recommendations for Decreasing Quantities of DUTP in Wilderness

Language (K)
- Develop one unified policy that visitors must pack out all used toilet paper
- Directly state policy and management desire
- Include 'toilet paper' in the slogans 'Recreate Responsibly,' 'Pack it Out," or 'Dispose of waste properly'
- Normalize the topic
- Stop using terms like gross

Content (K, A, P)
- Address ecological, economic, and social impacts of DUTP
- Clarify that "biodegradable" is not a universal term and burying toilet paper is unacceptable
- Create how-to videos
- Explain double sealing contains smells and leakage
- Explain how to make a wilderness toilet kit
- Give alternatives to toilet paper: pee rags, WAG bags, leaves, sticks, a water bottle bidet
- List annual number of visitors to wilderness area
- Share DUTP is a lack of education
- State if toilet kit needs to be in a bear hang
- Suggest duct tape as a privacy/visual containment strategy

Placement and Timing (K, P)
- Add to agency wilderness pages, as well as on wilderness rules page
- Combine promotion of stewardship practices simultaneously with promotion of benefits of nature
- Divide budgets equally between promotion and stewardship
- Have rules and regulations digitally available so stakeholders can to link to official policy
- Highlight pack out information on agency website pages as is done with "bear aware" campaigns.
- Offer pack out and alternative supplies alongside backpacking gear
- Post policy and how-to information on trailhead signs
- Post on official agency social media accounts throughout the year, concentrating on peak visitation
- Post on trip research locations such as AllTrails and hiker apps
- Enlist local businesses, Wilderness friend's groups, tourism promotional agencies, trendsetters, and sponsored athletes to post rules, regulations, and how-to information on websites, product packaging, and Facebook, Twitter, Instagram, and Tiktok accounts

Research (K)
- Address separately from human waste and litter

Box 1. Recommendations for decreasing quantites of DUTP.

Recommendations incorporate insights identified from deploying the KAP framework and respondents solution suggestions.

4.1.2 Content (Knowledge, Attitudes, Practices)

The data provided by this research fills a gap noted by Ben Lawhon, Senior Director of Research and Consulting at LNT, that organizations lacked specific reasons for why wilderness users fail to pack out toilet paper as input to develop effective marketing campaigns (B. Lawhon, personal communication, April 14, 2021). Content of messaging efforts needs to address wilderness visitor barriers to packing out used toilet paper (Fig. 5). For example,

Respondent HP8B stated that toilet paper was biodegradable, they learned their outdoor ethic based on common sense, but also confessed they would be a hypocrite if they stated seeing DUTP had an impact on them because they had just left toilet paper in the wilderness. Although this respondent had hiked the trail 11-15 times, passing trailhead signs that state to pack out toilet paper, they stated a desire for options as they didn't know how to properly pack out their used toilet paper.

Recommendations include addressing assumptions that biodegradable toilet paper can be left in the wilderness (Box 1). Management should directly state that biodegradable toilet is not an acceptable exception to the wilderness protocol to pack out all toilet paper. Stores that sell biodegradable toilet paper for backpackers need notices stating leaving biodegradable toilet paper may conflict with wilderness protocol. Messaging needs to address barriers by stating where to store used toilet paper in a backpack, how to contain smells, and how to create a wilderness toilet kit. Content can go beyond improving pack-out skills to providing alternatives to toilet paper. This social construct of dependency on using toilet paper is rarely examined in scientific, management, and tourism literature yet some respondents stated they already incorporate alternatives while other respondents stated a desire to learn about alternatives to packing in toilet paper.

Respondents recommended sharing pack-out information via how-to videos that detail sanitary methods to create, use, and store a toilet kit. For example, during a fall 2021 field research trip, a Coconino National Forest employee filmed an impromptu 3-minute video on how to make a toilet paper kit. The video was posted by the Coconino National Forest public relations department on their official Facebook page (Coconino National Forest, 2021). Within

the first 2 weeks, the video had more than 1200 views and 12 shares. These statistics depict the ease of disseminating correct content, the ability to reach a wide array of audiences, the affordability of addressing DUTP, and reenforces the topic of used toilet paper is neither taboo nor that it is something that people already understand.

Messaging content that addresses the impacts wilderness visitors experience, along with ecological and economic impacts of DUTP, can increase compliance of packing out used toilet paper. Respondents suggested content needs to share social impacts, which include the risk that DUTP can defeat the purpose of enjoying wilderness areas. Respondent attitudes are reflected by their willingness to give 20-25 minutes of their time when they expected to be finished with their trip and leaving the wilderness area shows. Respondents showed an open attitude toward behavioral change yet respondent attitudes toward wilderness users who leave DUTP behind were judgmental rather than understanding. Patience was granted toward litter deemed unintentional, such as lost water bottles and dropped protein bar wrappers, but respondents viewed DUTP as deliberate and disrespectful. Messaging content that shares DUTP is a lack of education could potentially reduce the intensity of seeing DUTP, facilitate sharing of peer-to-peer tools to successfully pack out used toilet paper, and transform litter from something to hate towards an opportunity to help.

Messaging content needs to address outdated visitor practices that could have been learned 40 years ago when burning or burying were acceptable practices. Incorporating wilderness visitor use numbers at trailheads can aid visitor knowledge on the cumulative impacts of these outdated and incorrect practices toward toilet paper disposal.

4.1.3 Placement and Timing (Knowledge, Practices)

Incorporating questions on practices identified the current approach of clustering toilet paper with litter fails to acknowledge required preparation time. Unlike litter, which can be stored in the side of a pack if wilderness visitors forget to bring a trash bag to pack it out, visitors require dedicated supplies for used toilet paper. Sharing rules and regulations before visitors arrive at the trail head acts on the necessary critical window of opportunity. Current management placement of information relies heavily on passive dissemination of policies and practices, primarily at trailhead signs and on the back of volunteer permits. The information conveyed is most applicable for future visits, should hikers recall the policy and if those policies are applicable for other wilderness visits. Placement of information in locations online where wilderness users can easily see rules and regulations and have time to act on them would improve compliance.

Respondent suggestions for placement locations include on websites and trail apps where they learned about the wilderness trails (Box 1). Official agency websites should have stated management desires easily accessible rather than buried on pages that require numerous clicks to find. Having this information digitally available will assist the outdoor recreation industry in linking to official management desires. Official social media accounts can be excellent ways to share desired wilderness management practices and provide information in time for users to act on it. The opportunities social media offers for public engagement feedback can build on results of this research and provide direction for continued educational campaigns. Additionally, agencies can share rules and regulations and how-to information with the outdoor organizations that respondents noted as outdoor ethics educators. Soliciting the

assistance of Boy and Girl Scouts organizations at the national level offers possibilities of disseminating correct information through their vast distribution networks. Helping seasoned hikers update their practices has the additional benefit of correct information being shared when these influencers introduce new users to the wilderness experience.

Enlisting the aid of outdoor recreation and tourism industries to directly state wilderness management desires to pack out toilet paper can help foster a cultural shift that recognizes the need to simultaneously promote stewardship practices alongside promoting the benefits and enjoyment of being outdoors (Kavallinis & Pizam, 1995). Recognizing and acting on this mutual sustainable accountability replicate the process used by Gunnison County, Colorado, Chamber of Commerce. Seeing the environmental degradation from increased tourism visitation tourists, the county ceased traditional marketing and shifted efforts toward sustainable tourism (Joe Lavorini, personal communication, June 23, 2021). This approach can be incentive for wilderness managers to balance monitoring efforts with more efficient education outreach campaigns using insights gained from this research. Another example of joint promotion and stewardship responsibilities is between the Sawtooth Wilderness management, the Sawtooth Wilderness friends' group Sawtooth Interpretive Historical Association, and the local ecotourism business Sawtooth Mountain Guides. Through this collaboration, free WAG bags are supplied at several trailheads in the Sawtooth Wilderness. Agencies would benefit from diversifying funds to support more of these types of joint stewardship efforts. The insights gained from asking respondents about their practices can incentivize managers and the outdoor recreation community to address DUTP directly.

4.2 DUTP as Separate Issue

The social construct of grouping DUTP with litter or human waste has prevented the identification of impacts DUTP has on wilderness users and for wilderness character. The potential fallout of continuing to make assumptions about toilet paper as litter or human waste is at the peril of the purpose of designated wilderness areas. Failing to correctly address this gap suggests quantities of DUTP are likely to increase along with associated implications for management to fulfill their legal mandates. Wilderness areas, such as the Boundary Waters Canoe Area Wilderness, have already been forced to constrain user access based in part on unacceptable quantities of DUTP (Kraker, 2021).

Respondents stated feeling robbed of their ability to be good stewards to the land with DUTP, whereas seeing other types of litter enable respondents to leave the area better than they found it, an identified trait among wilderness users (Weaver, 2013). Respondent stated the visibility of DUTP intruded upon their sense of solitude by bringing awareness of how much human waste might be surrounding them. Seeing DUTP recalled ecoanxiety, the environmental crises, and troubles of modern society, which crash against the restorative qualities of wilderness. As previously noted, combining used toilet paper with litter fails to address the need for advanced preparation to pack out used toilet paper, an identified root cause of existing quantities in wilderness areas.

The visibility of DUTP as compared to human waste resulted in respondents being more readily impacted by DUTP. Moreover, seeing DUTP enabled respondents to register existing quantities of human waste, impacting their comfort level with the area's sanitation. Likewise, in respondents often did not associate the word 'waste' used in outdoor ethic campaigns with

toilet paper, resulting in the assumptions that burying or burning toilet paper are acceptable practices (Fig. 5). Research that amalgamates used toilet paper with human waste fails to account for the social impacts experienced by seeing DUTP and therefore results in flawed messaging campaigns.

These specific impacts to this unique type of pollution reflect the low tolerance level respondents stated toward seeing unacceptable quantities of DUTP, levels at which they would cease returning to the wilderness (Fig. 4). DUTP is not unique in producing negative experiences able to defeat the purpose of wilderness areas. Wilderness users have reported altering their choices because of overcrowding and environmental degradation and also adapting to overcrowding. Given that litter has been a reported problem for more than 50 years, this suggests wilderness users also use adaptation skills to this type of pollution. Cilimburg et al (2000) found no studies on the social impacts of human waste and visitor adaptation remains unknown but management institutes new policies in response to unacceptable biological levels of human waste (*Inyo National Forest - Hiking*, n.d.). Management must monitor for this specific type of pollution to aptly apply resources toward DUTP concerns their wilderness management locations. Due to the increased numbers of visitors during and after COVID-19 and the resultant degradation to American public lands, management has stated the need for new tools to help visitors recreate in a more sustainable manner. US Forest Service has recognized the need to be proactive with educational efforts and increase communication with wilderness users in order to protect the wilderness resource (Hannon, 2021). The results of this research provide managers with the types of tools needed for more effective communication strategies,

the scientific evidence needed to seek increases in funding, and to make more effective decisions towards instituting permit restrictions.

4.3 GIS Analysis

This research identified respondents have a threshold level to seeing DUTP, that level was identified at 2.9 incidences, and the spatial analysis shows that threshold has already been breached (Fig. 4). This specific response to DUTP is unlike prior research, which found wilderness users adapt and cope rather than having specific cutoffs for degradation levels, (Cole & Hall, 2009). The spatial analysis shows an average of 4.2 incidences per campsite reveals DUTP is an issue in each of the wilderness areas surveyed (Table 1, Fig. 4). This type of litter is likely to be a problem throughout the NWPS based on 100% of respondents being negatively impacted by seeing DUTP. Respondents stated a low tolerance for seeing DUTP, but a discrepancy exists between how much they reported noticing and how much exists (Fig. 4). This suggests quantities will need to reach significant frequencies for wilderness users experience their tolerance levels. An urgency exists for a unified effort among wilderness management agencies and the outdoor recreation and tourism to use new approaches, as ones presented in this paper, while this buffer of disparity exists. Delays may result in increased displacement issues, the need for potentially politically and economically costly damage control measures, and negative impacts to communities with wilderness-based economies (Hall & Cole, 2007).

Although the baselines developed from the spatial analysis are not exhaustive, knowing the current quantities in these wilderness locations can assist wilderness managers in evaluating the success of any changes in policies, marketing, and educational campaigns.

Wilderness Management Plans should be updated to include DUTP as a specific indicator item to monitor during campsite evaluations, aiding each wilderness area in establishing their own baseline quantities. The quantities and distance spatial analysis results can help managers prioritize specific areas with more aggressive educational campaigns addressing the root causes of DUTP. Funding limitations often restrict wilderness management from acting on suggested research results, but the spatial analysis supplies the data wilderness managers have stated is needed to secure capital to address DUTP. The scientific data can also support management plans for instituting permits to reduce user impacts to wilderness areas (B. Mitchell, personal communication, February 24, 2022). Existing quantities of DUTP are disrupting the goal of managing wilderness for the most pristine conditions. DUTP must be addressed so it ceases to defeat the purpose of congressionally designated wilderness areas set aside for the enjoyment by current generations and future of the American public (The Wilderness Act, 1964).

4.4 Limitations and Future Research

The authors acknowledge that the 110 sample is not fully representative of hikers nor are hikers representative of all wilderness visitors. The findings from this research cannot be generalized to other areas, although the framework and identified social constructs may be applicable can serve as useful methods for larger issues of pollution. It should be noted that the in-person administration of the questionnaires may reflect a social desirability bias. Respondents stated a willingness to participate in the survey to assist with the master's project research. When conducting the KAP surveys, assumption was made that families with small children didn't have time to participate in the survey so the 35-50 age brackets may not be fully

represented. Seasonal and weekend rainy weather decreased the number of hikers visiting the wilderness areas, which may have influenced survey respondent numbers as well as quantities of DUTP at campsite locations. The erratic boat shuttle schedule at Redfish Inlet in SW restricted respondents' ability to complete the survey as well as promoted a willingness among other respondents to participate. The subjectivity of encountering wilderness campsites of identifying bathroom privacy locations may limit exact replication of spatial analysis.

Future research needs to provide further validation of the findings through longitudinal study designs. Additional KAP surveys and spatial analysis should be conducted to following changes to educational campaigns. Developing average distances from campsite center to incidences of DUTP would help managers assess camper compliance with digging cat holes 150 feet from water sources as well as help monitoring and cleanup efforts to more effectively locate DUTP. It is suggested future KAP surveys assess frequency of visitation to any wilderness area. More research is needed on sources of outdoor ethics, including assessing if state stewardship campaigns are influential methods in developing wilderness visitor ethics. Impacts of DUTP need to be expanded to ecological impacts as well as any resulting economic impacts shouldered by local businesses resulting from visitors reaching their DUTP thresholds and not returning to the local area. New products, such as those produced by PACT, need to be studied as alternatives to packing out toilet paper or as exceptions to any unified pack-out policy instituted by wilderness management agencies.

5. Conclusions

This research addresses the gaps of nonexistence knowledge about hiker impacts from seeing DUTP in wilderness and the lack of spatial analysis of DUTP in these areas. This research was the

to use the knowledge, attitudes, and practices (KAP) research framework for US wilderness issues. Deploying this survey approach identified the need to address DUTP as a unique topic rather than continuing the long-standing research and wilderness stakeholder approach that amalgams toilet paper with litter or with human waste. Examining the social constructs that lead to hiker behavior of DUTP identified new context-specific solutions. All advocates promoting the benefits of participating in wilderness and nature need to simultaneously provide specific stewardship tools that show visitors how to sustainably engage with nature. Messaging content needs to directly state management desires rather than relying on vague language; it needs to address hiker barriers so they can safely comply with rules and regulations; and content needs to be shared broadly across different media platforms to provide wilderness users preparation time to comply with rules and regulations.

This research identified a stated threshold exists for not returning to wilderness areas because of seeing DUTP and that this low threshold has already been breached. DUTP is a problem for wilderness visitors, for wilderness managers, and for government agencies, nonprofits, and the outdoor and tourism industries dependent on wilderness areas providing positive user experiences. Combining KAP research framework with on the ground fieldwork of spatial data resulted in the identification of an urgency for wilderness stakeholders to address this issue directly. Using the KAP method for environmental issues can help identify more effective solutions for long term sustainable engagement with nature.

Literature Cited

Ahmad, J., Noor, S. M., & Ismail, N. (2015). Investigating Students' Environmental Knowledge, Attitude, Practice and Communication. *Asian Social Science*, *11*(16), p284. https://doi.org/10.5539/ass.v11n16p284

Andrade, C., Menon, V., Ameen, S., & Kumar Praharaj, S. (2020). Designing and Conducting Knowledge, Attitude, and Practice Surveys in Psychiatry: Practical Guidance. *Indian Journal of Psychological Medicine*, *42*(5), 478–481. https://doi.org/10.1177/0253717620946111

Avitt, A. (2021, May 28). *National forest visits surged in 2020* [Press release]. US Forest Service, Department of Agriculture. http://www.fs.usda.gov/features/national-forest-visits-surged-2020

Banks, B. (2021, June 11). *Input on DUTP survey and spatial analysis sites* [Personal communication].

Benner, C. (2015, December 10). 4 Ways to Make Packing Out TP Less Gross. *Backpacker*. https://www.backpacker.com/skills/4-ways-to-make-packing-out-tp-less-gross-2/

Bratman, G. N., Olvera-Alvarez, H. A., & Gross, J. J. (2021). The affective benefits of nature exposure. *Social and Personality Psychology Compass*, *15*(8), e12630. https://doi.org/10.1111/spc3.12630

Cilimburg, A., Monz, C., & Kehoe, S. (2000). Wildland recreation and human waste: A review of problems, practices, and concerns. *Environmental Management*, *25*(6), 587–598. https://doi.org/10.1007/s002670010046

Coconino National Forest. (2021, October 19). *Northern Arizona University Master of Forestry student Elli Morris explains her quick, easy "toilet kit" for wilderness areas. It includes [video]*. https://www.facebook.com/CoconinoNF/videos/602315037613442/

Cole, D. N., & Hall, T. E. (2009). Perceived Effects of Setting Attributes on Visitor Experiences in Wilderness: Variation with Situational Context and Visitor Characteristics. *Environmental Management*, *44*(1), 24–36. https://doi.org/10.1007/s00267-009-9286-8

Cole, D. N., Petersen, M. E., & Lucas, R. C. (1987). *Managing wilderness recreation use: Common problems and potential solutions* (INT-GTR-230; p. INT-GTR-230). U.S. Department of Agriculture, Forest Service, Intermountain Research Station. https://doi.org/10.2737/INT-GTR-230

Cole, D. N., & Williams, D. R. (2012). Wilderness visitor experiences: Lessons from 50 years of research. *In: Cole, David N., Comp. Wilderness Visitor Experiences: Progress in Research and Management; 2011 April 4-7; Missoula, MT. Proc. RMRS-P-66. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 3-20.*, *66*, 3–20. http://www.fs.usda.gov/treesearch/pubs/40905

Cronon, W. (1996). The Trouble with Wilderness: Or, Getting Back to the Wrong Nature. *Environmental History*, *1*(1), 7–28. https://doi.org/10.2307/3985059

Dawson, P. (2021, September 24). *Seeking permission for NAU Master's project survey* [Personal communication].

Ehrampoush, M. (2005). Survey of Knowledge, Attitude and Practice of Yazd University of Medical Sciences Students about Solid Wastes Disposal and Recycling. *Iranian Journal of Environmental Health Science & Engineering*, *2*.

Fan, Y., Zhang, S., Li, Y., Li, Y., Zhang, T., Liu, W., & Jiang, H. (2018). Development and psychometric testing of the Knowledge, Attitudes and Practices (KAP) questionnaire among student Tuberculosis (TB) Patients (STBP-KAPQ) in China. *BMC Infectious Diseases*, *18*(1), 213. https://doi.org/10.1186/s12879-018-3122-9

Gopaul, C. D., Singh-Gopaul, A., Sutherland, J. M., & Chadee, D. D. (2016). Knowledge, Attitude and Practice among Drivers in Trinidad, West Indies. *Journal of Transportation Technologies*, *6*(5), 405–419. https://doi.org/10.4236/jtts.2016.65033

Goutille, F. (2009). *Knowledge, attitudes and practices for risk education: How to implement KAP surveys guideline for KAP survey manager* (October 2009). Handicap International - Humanity and Inclusion. https://reliefweb.int/report/world/knowledge-attitudes-and-practices-risk-education-how-implement-kap-surveys

Griffin, C. B. (2018). Camping Setbacks Near Waterbodies in Wilderness: Leave No Trace Messages and US Forest Service Regulations. *INTERNATIONAL JOURNAL OF WILDERNESS*, *24*(2). https://ijw.org/2018-camping-setbacks-near-waterbodies-in-wilderness/

Hall, T. E., & Cole, D. N. (2007). *Changes in the motivations, perceptions, and behaviors of recreation users: Displacement and coping in wilderness* (RMRS-RP-63; p. RMRS-RP-63). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. https://doi.org/10.2737/RMRS-RP-63

Hannon, A. (2021, December 2). *As visitor pressure rises, public land managers face new challenges*. Durango Herald. https://www.durangoherald.com/articles/as-visitor-pressure-rises-public-land-managers-face-new-challenges/

Hargreaves, T. (2011). Practicing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture*, *11*(1), 79–99. https://doi.org/10.1177/1469540510390500

Hawken, I. F., & Granoff, I. M. E. (2010). Reimagining park ideals: Toward effective human-inhabited protected areas. *Journal of Sustainable Forestry*, *29*(2/4), 122–134. https://doi.org/10.1080/10549810903543808

Hill, N. R. (2017). National Recreation Opportunity Spectrum (ROS) Inventory Mapping Protocol. *US Forest Service*, 74. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd628501.pdf

Hjerpe, E. E. (2018). Outdoor recreation as a sustainable export industry: A case study of the boundary waters wilderness. *Ecological Economics*, *146*, 60–68. https://doi.org/10.1016/j.ecolecon.2017.10.001

IIDS. (2006). Knowledge, Attitude and Practice (KAP) Survey under the Community-based Alternative Schooling Project (CASP) in Kathmandu District. *Institute for Integrated Development Studies (IIDS)*, 84. https://www.jica.go.jp/project/nepal/0602442/02/pdf/Baseline_KAP_Surveyin_Kathmandu_2006_May.pdf

Inyo National Forest—Hiking. (n.d.). Retrieved January 30, 2022, from https://www.fs.usda.gov/detail/inyo/recreation/hiking/?cid=stelprd3820395

Joe Lavorini. (2021, June 23). *NFF Introduction* [Personal communication].

Kavallinis, I., & Pizam, A. (1995). The environmental impacts of tourism—Whose responsibility is it anyway? The case study of Mykonos. *Journal of Travel Research*, *33*(2), 26–32. https://doi.org/10.1177/004728759403300205

Kiran, K. G., Kini, S., K, R., P, S. N., & Kiran, N. U. (2015). KAP study of solid waste disposal of households in Kuttar & Manjanadi Panchayath covered under gramaskhema programme of K.S. Hegde Medical Academy. *Journal of Health and Allied Sciences NU*, *05*(3), 29–35. https://doi.org/10.1055/s-0040-1703908

Kraker, D. (2021, December 2). *Forest Service to cut entry permits into the Boundary Waters*. MPR News. https://www.mprnews.org/story/2021/12/02/forest-service-to-cut-entry-permits-into-the-boundary-waters

Kranz, S. (2021, April 9). *Survey permission in SNRA* [Personal communication].

Kyle, A., & Brady, O. (2020, August 19). *National Forest Service: "We Had To Make A Decision To Close It To Dispersed Camping."* Drivin' & Vibin'. https://drivinvibin.com/2020/08/19/national-forest-service/

Landres, P., Vagias, W. M., & Stutzman, S. (2012). Using wilderness character to improve wilderness stewardship. *ParkScience*, *Volume 28*(Number 3, Winter 2011-2012), 8. https://www.fs.usda.gov/treesearch/pubs/40396

Launiala, A. (2009). How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. *Anthropology Matters*, *11*(1). https://doi.org/10.22582/am.v11i1.31

Lawhon, B. (2021, April 14). *LNT Questionnaire Input* [Personal communication].

Leung, Y.-F., & Marion, J. L. (2000). Recreation impacts and management in wilderness: A state-of-knowledge review. *Wilderness Science in a Time of Change Conference*, *5*, 23–48. https://www.fs.usda.gov/treesearch/pubs/21844

Lime, D. W. (1972). Large Groups in the Boundary Waters Canoe Area—Their Numbers, Characteristics, and Impact. *U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station*, *Research Note NC-142.*

Manning, R. E., & Lime, D. W. (2000). Defining and managing the quality of wilderness recreation experiences. In: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference-Volume 4: Wilderness visitors, experiences, and visitor management; 1999 May 23–27; Missoula, MT. *RMRS-P-15-VOL-4.*, *Volume 4*, 13–52. https://www.fs.usda.gov/treesearch/pubs/22002

Meikl, M. (2022, January 10). *Increased COVID-19-related litter threatens environment and wildlife*. European Wilderness Society. https://wilderness-society.org/increased-covid-19-related-litter-threatens-environment-and-wildlife/

Mitchell, B. (2022, February 24). *Pike National Forest monitoring protocol* [Personal communication].

Muth, R. M., & Clark, R. N. (1978). Public participation in wilderness and backcountry litter control: A review of research and management experience. *Gen. Tech. Rep. PNW-GTR-075. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 1-12.*, *075*. http://www.fs.usda.gov/treesearch/pubs/25148

NRM NVUM Results. (n.d.). Retrieved October 24, 2021, from https://apps.fs.usda.gov/nvum/results/A03004.aspx/FY2015

O'Connor, R. A., Nel, J. L., Roux, D. J., Leach, J., Lim-Camacho, L., Medvecky, F., van Kerkhoff, L., & Raman, S. (2021). The role of environmental managers in knowledge co-production: Insights from two case studies. *Environmental Science & Policy*, *116*, 188–195. https://doi.org/10.1016/j.envsci.2020.12.001

Rainey, J. (2021, March 11). *DUTP in Wilderness and Public Lands* [Personal communication].

Rav-Marathe, K., Wan, T. T. H., & Marathe, S. (2016). A Systematic Review of KAP-O Framework for Diabetes. *Medical Research Archives*, *3*(9). https://esmed.org/MRA/mra/article/view/483

Rawlins, S. C., Chen, A., Rawlins, J. M., Chadee, D. D., & Legall, G. (2007). A knowledge, attitude and practices study of the issues of climate change/variability impacts and public health in Trinidad and Tobago, and St Kitts and Nevis. *The West Indian Medical Journal*, *56*(2), 115–121. https://doi.org/10.1590/s0043-31442007000200003

Rudzitis, G. (2000). The Impact of Wilderness and Other Wildlands on Local Economies and Regional. *Proceedings RMRS.*, *2*(15), 14. https://www.fs.usda.gov/treesearch/pubs/21923

Saxena, A., Qui, K., & Robinson, S. (2018). Knowledge, attitudes and practices of climate adaptation actors towards resilience and transformation in a 1.5°C world. *Environmental Science & Policy*, *80*, 152–159. https://doi.org/10.1016/j.envsci.2017.11.001

Scott, M. (2021, August 1). *High use trail locations in SW* [Personal communication].

Sevigny, M. (2020). *Tourism During COVID-19, Part Two: National Forests*. KNAU. https://www.knau.org/post/tourism-during-covid-19-part-two-national-forests

SPRING. (2014, October 16). *The KAP Survey Model (Knowledge, Attitudes, and Practices)*. US AID From the American People. https://www.spring-nutrition.org/publications/tool-summaries/kap-survey-model-knowledge-attitudes-and-practices

Stanley, Idaho. (2022). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=Stanley,_Idaho&oldid=1078755757

Stewart, W., Cole, D., Manning, R., Valliere, W., Taylor, J., & Lee, M. (2000). Preparing for a day hike at Grand Canyon: What information is useful? In D. N. Cole, S. F. McCool, W. T. Borrie, & J. OLoughlin (Eds.), *Wilderness Science in a Time of Change Conference, Vol 4: Wilderness Visitors, Experiences, and Visitor Management* (Vol. 4, Issue 15, pp. 221–225). https://www.fs.usda.gov/rmrs/publications/preparing-day-hike-grand-canyon-what-useful

Taff, B. D., Rice, W. L., Lawhon, B., & Newman, P. (2021). Who Started, Stopped, and Continued Participating in Outdoor Recreation during the COVID-19 Pandemic in the United States? Results from a National Panel Study. *Land*, *10*(12), 1396. https://doi.org/10.3390/land10121396

The Wilderness Act, Pub. L. No. Pub.L. 88-577, 4 (1964).

Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of Educational Background on Students' Attitudes, Activity Levels, and Knowledge Concerning the Environment. *The Journal of Environmental Education*, *31*(3), 12–19. https://doi.org/10.1080/00958960009598640

Visitor Use Management. (n.d.). Wilderness Connect For Practitioners. Retrieved April 3, 2022, from https://wilderness.net/practitioners/toolboxes/visitor-use-management/default.php

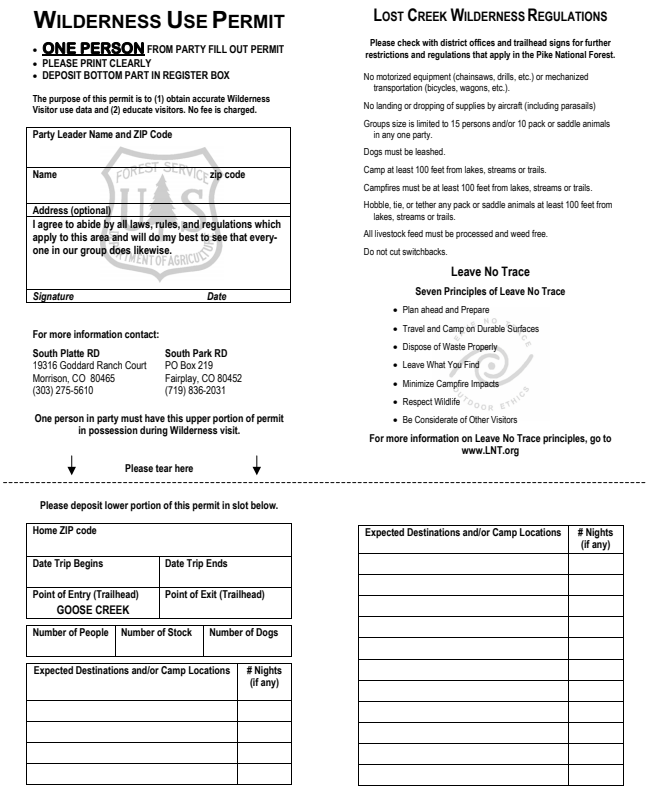
Wallace, G. N., Brooks, J. J., & Bates, M. L. (2004). *A Survey of Day and Overnight Backcountry/Wilderness Visitors in Rocky Mountain National Park*. 189. https://doi.org/10.13140/2.1.4341.5848

Warren, L. (2020). *National Visitor Use Monitoring Results*. 36. https://www.fs.usda.gov/sites/default/files/2020-National-Visitor-Use-Monitoring-Summary-Report.pdf

Weaver, D. B. (2013). Protected Area Visitor Willingness to Participate in Site Enhancement Activities. *Journal of Travel Research*, *52*(3), 377–391. https://doi.org/10.1177/0047287512467704

White, M. P., Alcock, I., Grellier, J., Wheeler, B. W., Hartig, T., Warber, S. L., Bone, A., Depledge, M. H., & Fleming, L. E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports*, *9*(1), 7730. https://doi.org/10.1038/s41598-019-44097-3

World Population Review. Flagstaff, Arizona Population 2022. (n.d.). Demographics, Maps, Graphs. Retrieved March 12, 2022, from https://worldpopulationreview.com/us-cities/flagstaff-az-population



WILDERNESS USE PERMIT

- **ONE PERSON** FROM PARTY FILL OUT PERMIT
- PLEASE PRINT CLEARLY
- DEPOSIT BOTTOM PART IN REGISTER BOX

The purpose of this permit is to (1) obtain accurate Wilderness Visitor use data and (2) educate visitors. No fee is charged.

Party Leader Name and ZIP Code
Name zip code
Address (optional)
I agree to abide by all laws, rules, and regulations which apply to this area and will do my best to see that everyone in our group does likewise.
Signature *Date*

For more information contact:

South Platte RD
19316 Goddard Ranch Court
Morrison, CO 80465
(303) 275-5610

South Park RD
PO Box 219
Fairplay, CO 80452
(719) 836-2031

One person in party must have this upper portion of permit in possession during Wilderness visit.

Please tear here

Please deposit lower portion of this permit in slot below.

Home ZIP code	
Date Trip Begins	Date Trip Ends
Point of Entry (Trailhead) GOOSE CREEK	Point of Exit (Trailhead)

Number of People	Number of Stock	Number of Dogs

Expected Destinations and/or Camp Locations	# Nights (if any)

LOST CREEK WILDERNESS REGULATIONS

Please check with district offices and trailhead signs for further restrictions and regulations that apply in the Pike National Forest.

No motorized equipment (chainsaws, drills, etc.) or mechanized transportation (bicycles, wagons, etc.).

No landing or dropping of supplies by aircraft (including parasails)

Groups size is limited to 15 persons and/or 10 pack or saddle animals in any one party.

Dogs must be leashed.

Camp at least 100 feet from lakes, streams or trails.

Campfires must be at least 100 feet from lakes, streams or trails.

Hobble, tie, or tether any pack or saddle animals at least 100 feet from lakes, streams or trails.

All livestock feed must be processed and weed free.

Do not cut switchbacks.

Leave No Trace

Seven Principles of Leave No Trace

- Plan ahead and Prepare
- Travel and Camp on Durable Surfaces
- Dispose of Waste Properly
- Leave What You Find
- Minimize Campfire Impacts
- Respect Wildlife
- Be Considerate of Other Visitors

For more information on Leave No Trace principles, go to www.LNT.org

Expected Destinations and/or Camp Locations	# Nights (if any)

Fig. S 1. Permit form.

Example of a self-issuing volunteer registration form, front and back.

VISITOR INFORMATION
Highest level of education
Age group
Occupation
Area affiliation
Income bracket
Zip code
Where raised
Gender
Political affiliation

WILDERNESS VISITATION
Length of visit
Primary reasons for visiting
Location of overnight camping
Number of visits to this wilderness

AREA VISITATION
Single visit or multiple locations
Length of stay in the area
Number of people in party
Accommodations in the local area
Visitation to local businesses
Budget for trip

RELATIONSHIP TO NATURE
Reasons for visiting local area
Outdoor ethic
Ethic align well-known principles
Where learned outdoor ethic
* Member environmental organization
Which organization
* Name five plants/wildlife in this Wilderness
* Consider cost of environment for purchases
* Do you volunteer
* Do you compost

PREPAREDNESS
^ Items brought for poop/pee
# See any signs to pack out TP
^ Bring anything to pack out TP
^ Specific item to pack out TP
# Biodegradability of TP
* Challenges face packing out TP
* Make more likely to pack out TP

IMPRESSION OF LANDSCAPE
See any pollution
* What type of pollution
# See any used TP
General area saw DUTP
Name of location saw DUTP
DUTP more prevalent than in past
* DUTP litter or human waste
* DUTP impact on Wilderness experience
* Description of impact from DUTP
* 3 top types of degradation
* #1 type of degradation
* Impact of DUTP versus overcrowding
* Threshold for not returning due to DUTP
* DUTP impact decision return Wilderness
* DUTP impact decision return local area
^ Altered recreation in the past from DUTP

FUTURE/SOLUTIONS
* Key challenges for the trip
* Priorities for next trip
* Solutions for decreasing DUTP
Email if want data analysis
Anything else like to add

Fig. S 2. The 57 KAP survey questions.

Questions were grouped into seven themes. Knowledge (#), attitudes (*), and practices (^) can overlap but marks are assigned to the concept most closely aligning to that category. Questions can be proxies for KAP.

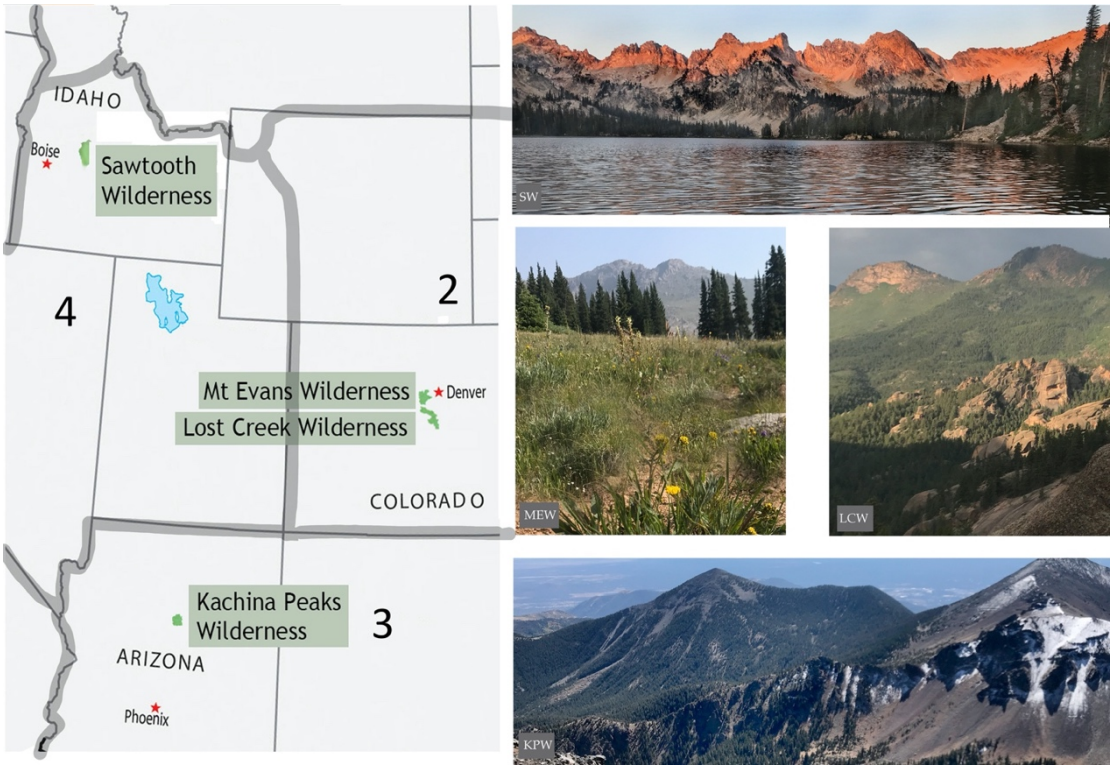


Fig. S 3. Map showing KAP survey locations.

Sawtooth Wilderness (SW), Mt Evans Wilderness (MEW), Lost Creek Wilderness (LCW), and Kachina Peaks Wilderness (KPW). Outline depicts US Forest Service Regions 2, 3, and 4.

Most impact on trip			DUTP compared to overcrowding		
	N	%		N	%
General trash	43	40.2	More of a concern	40	41.2
Overcrowding	23	21.5	Less of a concern	29	29.9
Wildlife harasssment	10	9.3	Neutral	23	23.7
Discarded used toilet paper	9	8.4	Highest concern	4	4.1
Human noise	7	6.5	Not a concern	1	1.0
Human waste	7	6.5			
Domestic animals	4	3.7			
Trail degradation	3	2.8			
Campsite proliferation	1	1.1			

Table S 1. Degradation ranking by respondents.

Respondents ranked general trash as the degradation that caused the greatest impact on their experience and ranked seeing DUTP as a higher concern than overcrowding.

	N	%
DUTP litter or human waste		
Litter	63	60.0
Human waste	16	15.2
Both	26	24.8
See any information on TP		
No		
Didn't read any signs	1	0.9
Didn't research	3	2.7
Didn't see any notices	81	73.0
Assumed with LNT	11	9.9
Assumed with Pack it Out	5	4.5
Yes		
Forest Service phone call	1	0.9
Forest Service Ranger talk	1	0.9
Forest Service website	2	1.8
Hiker posted on trail app	1	0.9
Label on TP	1	0.9
Maybe on REI list	1	0.9
Backpacking guide told me	1	0.9
Some article	1	0.9
Tourism website	1	0.9
Is TP biodegradable* (more than one answer)		
No		
Animals get to it before	6	5.9
No it is not	4	4.0
Not as fast as it is being left	13	12.9
Yes		
Depends on chemicals	14	13.9
Depends on landscape	7	6.9
Depends on printed design	4	4.0
Depends on product	27	26.7
It takes a long time	7	6.9
When buried	11	10.9
Yes it is	1	1.0
Not sure	7	6.9
Did you see any pollution* (saw more than one type)		
No	52	42.3
Yes		
Discarded used toilet paper	13	10.6
Dog poop bag	3	2.4
Enivronmental (haze, smoke, oil)	3	2.4
Food wrapper, aluminum foil, drink bottle, utensils	25	20.3
General trash, micro trash	27	22.0
How many incidences of DUTP did you see		
None	82	76.6
One	12	11.2
Two	8	7.5
Three	5	4.7
Where did you see DUTP		
Along the trail	19	61.3
At campsite	12	38.7
Amount of DUTP compared to last visit		
Much less	2	2.0
Less	7	6.9
About the same	23	22.8
More	1	1.0
N/A First visit	68	67.3

Table S 2. Visitor knowledge about DUTP.