THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF LANDSCAPE ARCHITECTURE AND THE DEPARTMENT OF RECREATION, PARKS, AND TOURISM MANAGEMENT

Research-Driven Design for Yellowstone's Northeast Corridor: An Interdisciplinary, Spatial Perspective on Visitor Behavior and Wildlife Interaction

OLIVIA G. KRUM
FALL 2024

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Landscape Architecture
with interdisciplinary honors in Landscape Architecture and Recreation, Parks and Tourism Management

Reviewed and approved* by the following:

L.J. Gorenflo, PhD
Eleanor R. Stuckeman Chair in Design
Professor of Landscape Architecture, Geography, African Studies, and Anthropology

Peter Newman, PhD
Martin Professor of Recreation, Park and Tourism Management
Department Head, Recreation, Park and Tourism Management
Penn State University

Andrew J. Mowen, Ph.D.
Professor; Professor-in-Charge of RPTM Honors Program
Recreation, Park and Tourism Management

* Electronic approvals are on file.

ABSTRACT

In Yellowstone National Park in the United States, escalating visitation and instances of human-wildlife conflicts pose a growing concern for both wildlife and visitors (National Park Service, 2020c). The first phase of the thesis is a preliminary study that aims to (1) evaluate the existing visitor behaviors, and conditions of infrastructure of the Northeast Corridor of Yellowstone National Park, and (2) determine if existing park infrastructure is associated with wildlife viewing behaviors. This topic has been largely unexplored in academic literature and may yield practical implications for future infrastructure design. The results of the study indicate that the infrastructure is heavily used and varied across study sites, and there is a statistically significant association in wildlife approach behavior between two of the four barrier types. It is important to note that, while the analysis demonstrates a statistical association, it is inconclusive regarding whether the barrier type itself was the sole variable influencing visitor behavior Future research on this topic may consider utilizing a more comprehensive study design that includes survey methodology and qualitative interviews to determine if types of barriers have a significant effect on visitor behavior concerning approaching wildlife in Yellowstone National Park. The data collected in the study was analyzed through a design lens to develop practical design strategies that may nudge visitor behavior to comply with park regulations. The sixth chapter of the thesis suggests infrastructural design typologies and strategies for nudging visitors to partake in positive wildlife viewing behaviors through a framework called "Cues to Social Conduct" focusing on the study site, Fossil Forest, as a practical application.

Keywords: landscape architecture, national parks, human-wildlife interaction, wildlife approach, picturesque, Nudge Theory, human wildlife conflict

Preface

In the realm of landscape architecture, the interplay between physical infrastructure and visitor behavior has long been a subject of consideration and importance. However, there is a void in existing academic literature that bridges the realms of behavioral model theories and the spatial environment, particularly within the context of managing human-wildlife interactions. This thesis sheds light on the intricate relationship between park design and visitor behavior, aiming to contribute valuable insights that may inform future park management and design strategies. It follows a transdisciplinary structure, crossing traditional boundaries that separate Parks and Tourism Management, landscape architecture, and aesthetic philosophy. It integrates these varying perspectives to understand the interplay between humans, wildlife, and infrastructure in United States National Parks, offering innovative ways to address the complex 21st century challenges resulting from high visitation in United States National Parks. I initially became attuned to visitor's perception of National Park infrastructure during visitor-surveying fieldwork conducted in Grand Teton and Yellowstone National Parks in 2021. Forty hours weeks for three months straight were dedicated to observing and engaging with park visitors as part of a study that scrutinized various aspects of wildlife approach behavior. These aspects encompassed the evaluation of persuasive messages' effectiveness, the examination of participants' emotional responses to wildlife viewing, the exploration of their decision-making processes, and the assessment of their ability to estimate the park's recommended distance (Freeman, 2022). One of the study sites in Grand Teton is named Elk Ranch Flats, a roadway pull-off characterized by historical fences that are remnants of the area's ranching history. These five-foot tall fences lined through the open field that is frequented by American Bison for grazing. During the survey, participants were directed to position themselves at the commencement of an unknown distance transect leading to a life-size cutout of an American Bison. I observed separate from the components of the study, that visitors, without any prompting, consistently employed the fence as a reference point for measuring and determining their stopping distance when approaching wildlife. It appeared that visitors perceived this fence as a visual cue guiding their definition of safe wildlife approach behavior. One might wonder if such a phenomenon could be used to park managements' advantage. Other observations surfaced during the section of the study conducted in Yellowstone National Park. Engaging in conversations with park visitors, the researcher uncovered that many visitors were unaware that national park front-country areas were curated and intentionally designed. Interestingly, these same visitors often failed to recognize that the wildlife roaming throughout the town in Mammoth Hot Springs was indeed wild, revealing a peculiar disconnect from the reality of the situation at hand. These initial observations and conversations in 2021, while seemingly insignificant at the time, resonated with the me as a compelling connection between human behavior, park infrastructure, and wildlife approach, which would later serve as the inspiration for this thesis. This thesis utilizes a subset of variables from a mixed-methods parent-study through the Pennsylvania State University Protected Areas Research Collaborative (PARC). The research team worked with the Yellowstone Conservation Resources Center through a partnership under the Cooperative Ecosystems Study Unit national network (CESU) to determine both variables and study sites that will help inform park management of both visitors and natural resources. This present study specifically probes the relationship between visitor behavior and existing park infrastructure to understand the role of landscape architectural design in managing visitor behavior and human-wildlife interaction.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I could fulfill the length requirements of my thesis with the acknowledgments section alone, and it still would not be enough to show my gratitude for the people who have helped me through this four-year process. To my parents, I dedicate this thesis to you. The sacrifices you both have made, the love you give, and the support you provide for me and David to grow as individuals and scholars is some kind of magic. To my brother, David, who pushed me to apply to Schreyer when I did not think I was even smart enough to get into Penn State. To Charlie, who holds me together every day and puts up with the travel, bears, and floods. To the Romig family, who have supported and loved me at my best and worst. To Dr. Buckley, who is the sole reason this thesis is finished, and who has taught me everything I know about field-research, social science, and how to just be a human who is growing-up. To Dr. Gorenflo, who may or may not approve this thesis, but has nonetheless provided me with endless encouragement and support throughout my time as a student, and thesis advisee. To Dr. Taff, Dr. Mowen and Dr. Newman, who saw my excitement for everything National Parks and gave me the direction I needed to follow my passion. To the Mainzers, who always know exactly what I need, even before I do. To my dear friends who have listened to me ramble on about my thesis until ungodly hours. To the Department of Landscape Architecture, and the Department of Recreation, Parks, and Tourism Management, and the incredible faculty and staff who have shaped me into the scholar I have become. To the National Park Service, and the Yellowstone Conservation Resources Center for being kind hosts and providing me with ample training and data. To the Schreyer Honors College who pushed me to be a student that I did not know I was capable of being.

Chapter 1

INTRODUCTION

The design of United States National Parks (USNP) utilizes techniques to create picturesque aesthetics aimed at evoking feelings of awe (Carr, 1999, pp. 11-13). Studies point toward a possible relationship between experiencing awe and proximity-related wildlife approach behavior (Schänzel and McIntosh, 2010). This heightened sense of awe, induced by the USNP design, may, in turn, contribute to increased proximity-related wildlife approach (Freeman, 2022). In addition, increasing visitation numbers in Parks and Protected Areas (PPA) nationwide are challenging park management's ability to maintain their dual mandate legislated by the Organic Act of 1916 to both manage visitor use and preserve natural resources (National Park Service, 2023b). In Yellowstone National Park, escalating visitation, and instances of human-wildlife conflicts pose a growing concern for wildlife and visitors (NPS, 2020; NPS 2023c). In addition, the aging infrastructure that exists in the park from the 1960s reflects past National Park use that do not match the orientation goals of the park service or demands of current visitation (Carr, 2007, pp. 68 -84).

The purpose of this thesis is to add to the body of literature surrounding human-wildlife interaction by grounding human behavior in landscapes. In return, it may yield practical implications for designing park infrastructure that serves as indirect visitor management, theoretically reducing non-compliant wild-life approach behavior.

This preliminary study seeks to understand how existing park infrastructure in the Northeast Front Country Corridor of Yellowstone National Park are associated with wildlife

viewing behaviors, a topic which has been largely unexplored in academic literature. The study aims to evaluate whether there is a statistically significant association in wildlife approach behavior between four different types of infrastructural barriers that are present at the study sites in Lamar Valley, Yellowstone National Park: split-rail fences, logs, rock barriers, and a fence and log barrier combination. In terms of this thesis, wildlife approach behavior is a term used to describe human behavior where an individual approaches wildlife, regardless of intention.
The objectives of this thesis are as follows:

(1) Categorize current infrastructural elements and visitor behaviors in the pull-offs

(2) Analyze if the barriers are associated with wildlife-approach behavior

(3) Assess which pull-offs need design intervention.

(4) Design infrastructural design typologies and strategies for nudging visitors to partake in positive wildlife viewing behaviors by utilizing data that was collected.

Research Question: Is there a difference between the means of visitors approaching wildlife based on the type of barrier present at roadside scenic pull-offs in Yellowstone National Park?

Location of Study

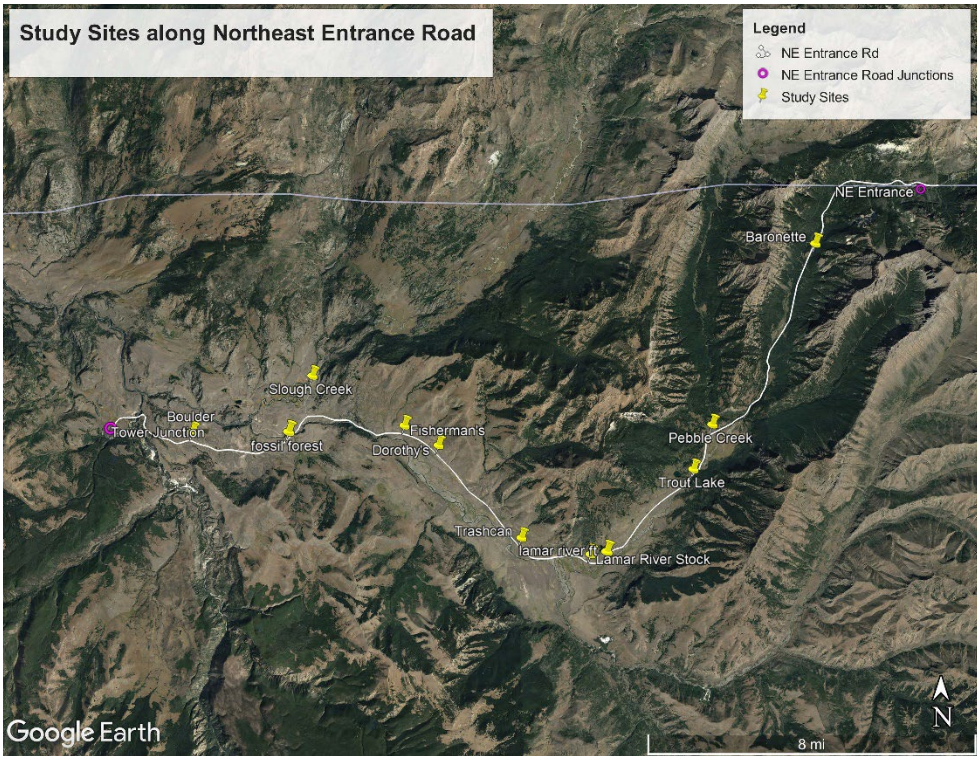


Figure 1. Study Location. Yellowstone National Park (orange). Northeast Entrance Road (white).

The study is located within the Northeast Corridor of Yellowstone National Park, United States (Fig.1). The study sites are eleven vehicular pull-offs on Northeast Entrance Road (Fig.2). The sites were strategically chosen by the research team and park personnel in the Yellowstone Center for Resources due to their high use. This front country corridor is the primary vehicular circulation corridor within the Northeast Tower and Lamar Valley region of Yellowstone. The roadway is the primary interface between visitors and park wildlife. Lamar Valley is renowned as one of the best places in the United States for wildlife viewing (NPS, 2023a). Visitors can observe a wide variety of wildlife, including American bison (*Bison bison*), elk (*Cervus canadensis*), grizzly bears (*Ursus arctos horribilis*), wolves (*Canis lupus*), and various other species of megafauna and other fauna

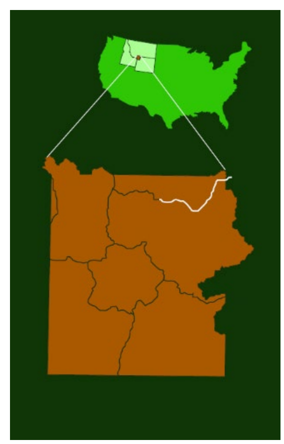


Figure 2. Map of study sites along NE Entrance Road, Yellowstone National Park

Chapter 2 LITERATURE REVIEW

Behavioral Theories and the Landscape

Landscapes are not just physical space, but a web of cultural and social constructs that create complex environments of living and non-living entities factors (Greider and Garkovich, 1994; Mainzer and Luloff, 2017). Literature suggests that emotions of awe are tied to being in landscapes in which individuals feel a sense of place (Moore and Graefe, 1994; Kaltenborn and Bjerke, 2002; Ward and Roggenbuck, 2003; Kyle et al., 2004; Carr, 2016, XiaoXiao, Liang, and YingChun, 2018). Emotions are complex psychological and physiological responses to stimuli or situations that involve subjective feelings, thoughts, and physical reactions. They play a fundamental role in being human, influencing how we perceive, interpret, and respond to the environments (Jackson, 1994; Ajzen and Fishbein, 2000). Place is a multi-dimensional, socially constructed space that holds significant psychological and symbolic meanings for individuals and communities. A place may carry emotional attachments, memories, and cultural or historical significance (Tuan, 1979, pp. 387-427). Place attachment theory has been applied to studies in public landscape settings, many of which finding that when people feel emotionally attached to a place and identify with its cultural and social aspects, it influences the way they interact with and engage in activities within that place (Agrawal and Gibson, 1999; Eisenhauer et al, 2000; Simpson and Belsky, 2008; Moore et al., 2012; Carr 2016). This can include spending time there, taking part in events or traditions associated with the place, or even caring for and maintaining the place themselves (Eisenhauer et al., 2000; Claus et al., 2010; Parrott and Meyer, 2012). This has been examined in relation to studying the efficacy of pro environmental behavioral interventions.

Behaviors are observable actions in response to internal or external stimuli, situations, or circumstances. Interventions are deliberate actions, strategies, or approaches designed to bring about changes in individual or group behavior. Pro environmental interventions are a general term for approaches that encourage positive human behaviors aligning with resource conservation and sustainability goals (Ajzen and Fishbein, 2000; Steg and Vlek, 2009). One example of pro environmental behavioral intervention application in national parks that utilizes spatial context is persuasive communication and signage, which is developed under the theory of the planned behavior framework (TPB) (Miller and Freimund, 2018; Abrams et al., 2020, Lawhon et al., 2013, Freeman et al. 2021, 2023). TPB acknowledges that social and physical context is background for three primary drivers for intentions and behavior: attitudes, perceived behavioral control, and subjective norms (Ajzen, 1991). However, others urge that a transdisciplinary, field-theory-based model to understand pro-environmental behavior orientations may prove to be more comprehensive (Fogg, 2009; Mainzer and Luloff 2017. One proposed framework that seeks to identify a model for understanding behavior sensitive to the complex relationship between communities and the landscape, and community-sensitive field-work methodologies under a more holistic community-landscape theory of pro-environmental behavior framework (Mainzer and Luloff, 2017).

Nudge theory is another behavioral intervention theory brought forth by Richard Thaler and Cass Sunstein in their book - "Nudge: Improving Decisions About Health, Wealth, and Happiness". Thaler and Sunstein discuss the theory and its relation to policy and health, but the theory has been applied in various areas, including public policy, marketing, and environmental conservation, to promote positive behaviors and decision-making (Arno and Thomas, 2016). Thaler and Sunstein theorize that individuals can be gently guided toward better choices without active management, mandates, or restrictions (Thaler and Sunstein, 2008). Nudge theory acknowledges the influence of cognitive biases and seeks to improve decision-making by subtly altering the way choices are presented, without restricting individual freedom. However, Thaler and Sunstein were highly criticized for their use of the term "liberal paternalism" to describe nudge, in which they argue that it is legitimate and possible for institutions to influence behavior while simultaneously allowing for freedom of choice. A significant reevaluation of Nudge theory was presented by Pedwell (2017). Pedwell argued in favor of offering subtle tweaks to shape unconscious automated, and habitual behavior, but argues that the actions are far from neutral. Instead, Pedwell discusses that liberal paternalism is paradoxical, and that the behavior change agenda is charged with disempowerment to outsmart human habits. One may be able to draw parallel to Nudge theory and the extensive history of design practices of both architects and landscape architects, who shape the everyday environment. Moreover, these practices are far from neutral and have strong ramifications on communities, natural resources, and behavior (Carr, 1999, pp. 28-35); Brown et al., 2012). Landscapes are shaped by humans, and in turn reflect the cultural values of those who exist and shape them. This can change over time as societal values evolve (Agrawal and Gibson, 1999). Through observing the landscape and humans that inhabit them, one can begin to understand human connection with the landscape. Studying such landscapes and their complex histories can provide simple but impactful insight into how to best conserve natural resources, and the case is the same in United States National Parks (Whyte, 1984; McClelland, 1998, Agrawal and Gibson, 1999; Parrott and Meyer, 2012).

The Picturesque, Awe, and The United States National Park Rustic Design Vernacular

The visitor experience in USNP is intricately connected to national park design building on naturalistic vernacular and picturesque aesthetics. This naturalistic, or rustic, landscape design vernacular in American national parks is derived from mid-18th century English landscape style design (Carr, 1999, pp. 11-80; McClelland, 1998, pp. 17-39). Naturalistic design is characterized by altering the landscape to achieve seemingly untouched, picturesque aesthetics. Aesthetics is a branch of philosophy that explores the questions related to the perception and appreciation of beauty, as well as the principles and criteria that guide our judgments of what is aesthetically pleasing or valuable (Graham, 2005). The picturesque is an aesthetic concept that conjures an emotional sensation characterized as a harmonious blend of two other aesthetic experiences: the sublime and beauty (Myers, 2006; Burke, 2022). Sublime, in reference to its historical and present-day use, is derived from the English Romantic period. It is another philosophical and aesthetic term that refers to experiences or things that inspire a sense of awe, grandeur, and it is often used in relation to emotions resulting from experiencing the landscape (Reid, 1994). The sublime is typically associated with a feeling of transcendence and can evoke both beauty and fear at the same time. The emotions created by sublime directly parallel that of awe, which is defined as an intense emotional and cognitive response to encountering something that is so vast, powerful, or awe-inspiring that it surpasses one's ability to fully comprehend it (Bourassa, 1990; Myers, 2006; Shaw, 2017; Burke, 2022). The designs of national parks and parkways are considered picturesque, owing to national park designer and engineers abilities to conceive and craft experiences that seamlessly merge the inherent beauty of the native landscape with sublime engineering marvels (Myers, 2004). This union results in parkways and scenic overlooks that are well known for their ability to exhilarate park visitors, such as 'Going-to-the-Sun Road' in Glacier National Park, designed by Thomas Chalmers Vint (Carr, 2007) (Fig.3).

The sublime in National parks was largely enhanced and tailored through picturesque design practices (Carr, 1999, pp. 1-10). One technique used to enhance picturesque is the creation of a vista, or framed view, which is often used on scenic parkways and overlooks. This technique involves carefully framing and composing elements of the landscape such as vegetation or landform to

Figure 4. Triple Arches of Going to The Sun Road, Glacier National Park US. (NPS, 2023)

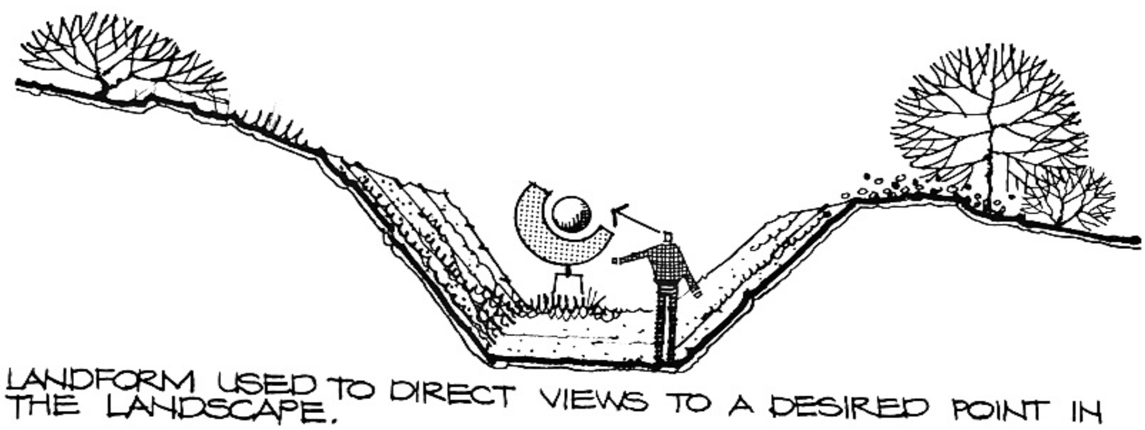


Figure 3. Designing landscapes to direct viewing behavior toward a desired area (Booth, 1989, pp. 53)

create pictorial space, directing visitors attention toward specific viewpoints (Fig. 4). Vistas create visual corridors, which are often used for photography, as well as for an inferred boundary between the viewer and the view (Kryder-Reid, 1994). Designed aesthetic experiences have been studied in nature-based tourism to understand visitors' perception and associations with their surroundings (Zhang and Xu, 2020).

A study completed by Stephanie Freeman (2022) performed qualitative interviews regarding visitors' emotional responses to experiencing wildlife in the setting of Yellowstone National Park. The following quote is from a park visitor that was interviewed for the study:

(YELL, Interview #9).

"Yeah. I was telling my wife that I think I'm just going to stop taking pictures for a while because everything is so picturesque. It doesn't really matter where you point a camera. It's going to look good. So, yeah, that's pretty awe – amazing"

One example of the use of this technique is 'Snake River overlook' in Grand Teton National Park, which is famous for its ideal visual composition that was capitalized on by the famous photographer, Ansel Adams, who took the photo "Tetons and Snake River" which depicts the Teton Mountains and snake river framed by tall trees (Fig.5). Visitor experiences and behaviors in USNP continue to be shaped by the complex design history that exists as a palimpsest of enduring traces of landscape architects and engineer's past.

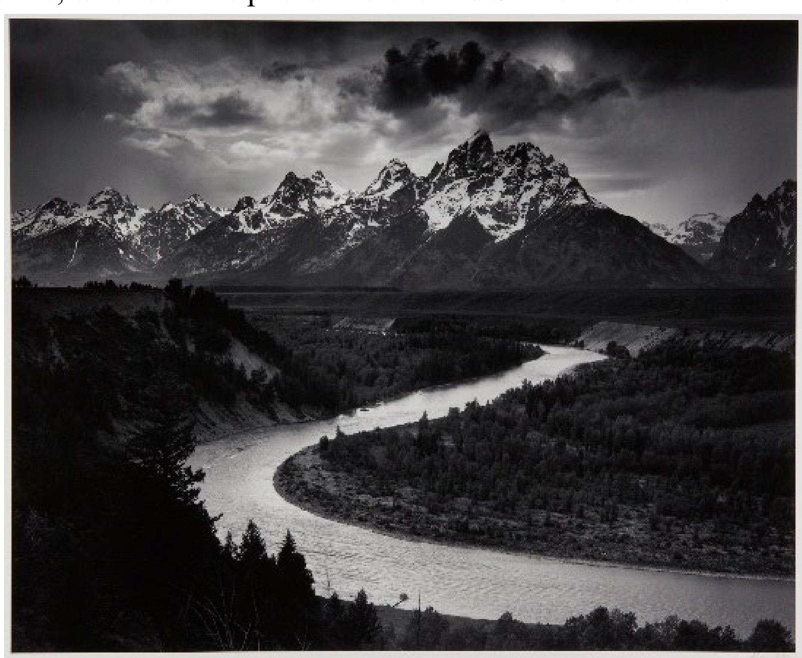


Figure 5 Tetons and Snake River Photograph, Ansel Adams (1942 Negative)

Mission 66 is the last system-wide development initiative in the National Park Service that took place following World War II, and it is responsible for much of the infrastructure and services that exist within USNP today. The initiative is highly controversial and largely credited to the modern-day conservation movement that arose in opposition to it (Carr, 2007, pp. 1-21). This modernization effort resulted in the construction of visitor centers, campgrounds, and expanded vehicular circulation facilities, providing park visitors with more comfortable and convenient amenities. However, in the pursuit of a modern aesthetic and functionality, there was little consideration for how mid-century modernism ideals and aesthetics would impact the national parks in the future, nor did it consider how visitors would respond to infrastructure in wildlife viewing settings (Carr, 2007, pp. 175-193). Mission 66 improvements were made to roads and road infrastructure throughout Yellowstone National Park, including Lamar Valley. Roadway pull-offs and overlooks were added or enhanced during this period to provide visitors with convenient locations to stop and view wildlife. This infrastructure largely persists today.

Contemporary Challenges, Human Wildlife Approach, and Lamar Valley

Yellowstone had 3,290,242 visits in 2022 and 20,091,078 visits over the past five years (National Park Service, 2023d). As visitation to USNP remains at record-high levels, solutions to manage visitor volume have been developed such as the use of timed entry, permitting, and other forms of controlled circulation. Yellowstone has yet to implement any of these systems, but they are eager for solutions to manage extremely high visitation (Yellowstone Park personnel, personal communication, 2022).

Additionally, studies have shown that a key component of high-quality visitor experiences when visiting these protected lands is to view wild megafauna (Hammitt et al., 1993; Lemelin & Smale, 2006; Anderson et al., 2010; Freeman et al., 2023). The Northeast Corridor, specifically the Lamar Valley, has earned its reputation as one of the premier wildlife viewing destinations in the United States, also known as the Serengeti of the United State (Hefferan, 2023). With its spectacular wildlife viewing opportunities also comes challenges in managing human-wildlife interaction (HWI). HWI is the dynamic interplay between humans and wildlife (Hammitt et al., 1993). In the context of United States National Parks, this interaction occurs between human visitors and the park's animal inhabitants. Literature that suggests that wildlife viewing in national parks elicits emotions of awe when viewing wildlife in national parks sceneries, and that such emotional responses may drive wildlife approach behavior at noncompliant distances, especially in terms of viewing and photographing wildlife closely (Freeman et al., 2021).

NPS considers wildlife approach behavior non-compliant and recommends that visitors maintain 25 yards from ungulates and 100 yards from bears and wolves (National Park Service, 2020a). However, in areas where infrastructure is weaved through primary wildlife habitat, this distance is not met because (1) visitors whose satisfaction is associated with being nearer to wildlife and to see them closely and (2) wildlife who are directly adjacent to infrastructure because of the patterns of park development. In cases of scenic overlooks and roadway pull-offs, if visitors disregard the figurative, pictorial boundary that separates them from the expansive views, human-wildlife conflicts (HWC) can result (Hammitt et al., 1993; Schänzel and McIntosh, 2000). Human wildlife conflict is when human actions and behaviors disrupt the natural behaviors and habitat of wildlife (Freeman et al., 2021). These conflicts have significant implications for the safety and well-being of both park visitors and wildlife, including increased mortality rates and the displacement or relocation of wildlife. Additionally, studies have found that injuries resulting from wildlife approach behavior at unsafe distances occur every year. Keltner and Haidt, 2003; Lemelin and Smale, 2006; Miller and Freimund, 2018; Mateer et al., 2020, National Park Service, 2020).

The design of national parks utilizes techniques to create picturesque aesthetics aimed at evoking feelings of awe. Studies have pointed toward a possible relationship between experiencing awe and proximity-related wildlife approach behavior. This heightened sense of awe, induced by the park's design, may, in turn, contribute to an increased proximity-related wildlife approach. In addition, escalating visitation and instances of human-wildlife conflicts pose a growing concern for wildlife and visitors in Lamar Valley. Mission 66 infrastructure, which mirrors past National Park use and may not meet orientation goals of the park service and demands of current visitation, necessitates a thorough reevaluation. This study provides initial first steps toward highlighting a need for park infrastructure that is designed to foster positive and compliant visitor behavior.

Chapter 3

METHODOLOGY

Observation Instrument

Observations were recorded as quantitative data via tablet using the Qualtrics offline survey application (Fig.6). Data was uploaded by the technicians at the end of every shift. Infrastructural inventory of the study sites was done prior to the first day of data collection to tailor the observation sheet to specific infrastructure.

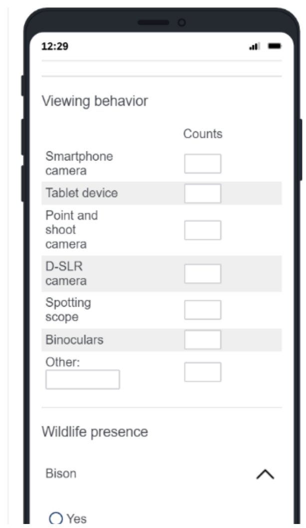


Figure 6. Qualtrics Offline Survey Application used as Observation Instrument

Five categories of infrastructure and use indicators were inventoried and are described further in results:

- **Barrier-Type**
- **Signage-Type**
- **Trail-Type**
- **Surface Treatment-Type**
- **Edge Effects**

Unobtrusive observational methodology was developed and utilized by referencing methodologies utilized in prior park-based studies. The research team meticulously designed the instrument to ensure that the observations being collected were site-specific, and that variables being examined would produce data that is relevant for park management, planners, and landscape architects. Three practice data-collection days were allotted to pilot and adjust the observation instrument. A mixed-scoring response format including yes/no and forced-choice response was designed (appendix1-5). This means that responses were either programmed to be answered yes or no, or they were multiple choice responses that exclude neutral or empty responses. Variables included on the observational data collection sheet were largely informed by existing literature on human-wildlife conflict, and the expertise of senior researchers on the project. Wildlife presence and wildlife-viewing behaviors were coded into the following variable categories:

1. **Elevated Viewing:** This category involves instances where individuals positioned themselves at elevated vantage points to observe wildlife or natural surroundings. It often involved the use of climbing vehicles and infrastructure.
2. **Wildlife Approach:** This category encompasses observable pedestrian behaviors where individuals approached wildlife. In this study, the main indicator of wildlife approach involves individuals crossing the threshold of the pullout (determined by research team) in the direction of wildlife.
3. **Device-Based Viewing:** This category of variables captures individuals utilizing technological devices, such as cameras, binoculars, scopes, or smartphones, to enhance their wildlife-viewing experience.
4. **Wildlife Presence:** A binary (y/n) presence variable was collected for the following species:

Table 1. Forced-Response Wildlife Presence Variable for Wildlife Species in Lamar Valley, Yellowstone National Park

Common Name	Scientific Name
American Bison	*Bison bison*
Big Horn Sheep	*Ovis canadensis*
American Black Bear	*Ursus americanus*
Coyote	*Canis latrans*
Mule Deer	*Odocoileus hemionus*
Elk	*Cervus canadensis*
Gray Fox	*Urocyon cinereoargenteus*
Grizzly Bear	*Ursus arctos horribilis*
Moose	*Alces alces*
Pronghorn	*Antilocapra americana*
Gray Wolf	*Canis lupus*

Sampling

The sample consisted of Yellowstone National Park visitors who were observed in the pull-offs of the Northeast Corridor. The data was collected in a randomized time-series format. Unobtrusive observations are made at eleven pre-selected, high visitation pull-off sites. The study sites were selected through a collaborative and iterative process among the researchers and park personnel to cover a breadth of distance and challenges along the Northeast Corridor. The sampling was designed to be distributed across eleven high-visitation roadway pull-off sites over a two-month period. We allocate 26 days for data collection. The collection stratified randomly by (1.) the direction at which technicians began the driving transect, (2.) the time of day they collect data (AM/PM), and (3.) by weekday or weekends. AM shifts occurred from 6 AM to 2 PM, and PM shifts took place from 12 PM to 8 PM. The field season began on May 28 and ended on July 10 to achieve the desired sample size. Due to the historic flooding event that occurred in YELL in June of 2022, the technician crew evacuated on June 16. Due to these unforeseen circumstances, data collection occurs for only 11 of the allotted 26 days, thus causing the final sample size of the study to be smaller than the team had anticipated.

Protocol

Technicians dressed in plain clothes and discrete blue safety vests, and they inconspicuously observed visitors at the selected sampling sites. They took care to minimize engaging with visitors as to not bias visitor behavior. Blue vests were enforced as a safety precaution due to the nature of collecting data in high vehicular traffic areas (Fig.7). At each sampling site, the technicians were directed to record observations and counts of visitor behaviors, following specific definitions on what constitutes a behavior of interest during training. Examples of these defined parameters include determining the threshold of each pullout and how to properly collect observations in dynamic, high-visitation areas.

Figure 7 Technician in the field collecting data

At each sampling site, the research technicians were advised to do the following:

1. Using a global positioning system, they navigate to the provided coordinates for the site.
2. Once they arrive, they mark the time (hour:minutes) and promptly begin observations.

3. Starting from one side of the site, the technician moves across the transect, collecting behavioral observations on the Qualtrics data sheet.

4. After completing observations, they drive to the next observation site on the transect and repeat steps 1-3.

5. After conducting counts at all eleven sites, they wait 15 minutes and then drive the transect in reverse, repeating steps 1-4.

The sampling locations are arranged from west (1.Boulder) to east (11.Baronette) (Fig.2). A driving transect includes one full direction, west-to-east or east-to-west, determined randomly by a random number generator at the beginning of each shift. Technicians complete the fullest driving transects that they can per shift. However, incomplete transects are discouraged due to the concern of inconsistent data collection per site.

Chapter 4

ANALYSIS

Descriptive Analysis

The data exploration process was initiated by completing several essential tasks. First, data cleaning and validation procedures were employed to ensure data quality. This involved checking, removing, and recomputing missing values and data inconsistencies, respectively. The data that was recorded at a species-specific level to gather generalized wild-life approach data was recomputed as a total wildlife variable. The initial focus of the analysis was on exploring descriptive data rather than formulating specific research questions. A total of 258 randomized time-series observations were gathered and distributed evenly across the study sites, forming the basis for the analysis (appendix B).

To understand the distribution of infrastructure types across the study sites, a visual cross-tabulation was used. This analytical method helps to discern how different types of infrastructure are distributed throughout the study area, and where the categories occur at the same time This analysis is integral in determining roadway pull-off typologies and understanding the prevalence of infrastructure types across the sites.

In addition to examining infrastructure, the researcher also used descriptive statistical analysis to inspect the frequency of wildlife viewing behaviors, and measures of central tendency to examine the total amount of visitors observed.

The findings from these exploratory analyses were utilized and examined comprehensively in the subsequent, inferential section of the analysis, and offered valuable insights into the distribution of infrastructure, wildlife viewing behavior, and the presence of various species in the study area.

Inferential Analysis

To investigate if the type of barrier present at roadside scenic pull-offs has a statistically significant effect on Yellowstone National Park visitor wildlife approach behavior among four different barrier types, the researcher utilized inferential statistical analyses. The inferential analysis was narrowed to examine the relationship between visitor approaches to wildlife and the four barrier types present across the sites. Barriers were chosen as the infrastructure to examine to narrow the scope of the study. The observations (N) for the following analyses are 434. Initially, a visual inspection of a Quantile-Quantile (Q-Q) plot was conducted to assess whether the dataset followed a normal distribution. A Q-Q plot is a visual test for normality. No remedial actions were taken to address non-normality. The visual examination of the Q-Q plot suggested that the data did not conform to the normality assumption required for parametric testing (Fig.8). Therefore, non-parametric tests were used. Subsequently, a comparison of means was

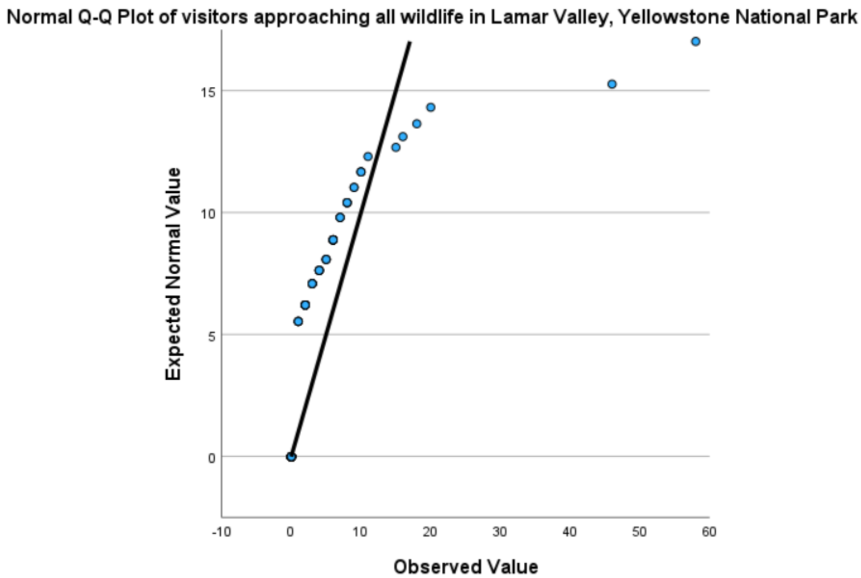


Figure 8 Q-Q Plot Test Indicating Non-Normality

performed to determine if the means of visitors approaching wildlife were different across the four barrier-types. To understand if there is a significant difference between the means of visitors approaching wildlife across the boundaries, an independent samples Kruskal-Wallis test was used. The following null hypothesis was formulated: There is no statistically significant difference in wildlife approach behavior among the four different barrier types.

Chapter 5

RESULTS AND DISCUSSION

The results from the analysis indicate that the pull-offs examined in the study are highly varied in their spatial layout, and they are experiencing high visitor volume, high use-impacts, and high wildlife-approach behaviors- all of which are challenges susceptible to design solutions. The past design of United States National Parks has focused on emphasizing the picturesque aesthetic and resulting emotions of awe. However, studies point toward a possible relationship between experiencing awe and proximity-related wildlife approach behavior. Design solutions are needed to seek balance between the aesthetic qualities of USNP design and the current demands of visitation. The existing infrastructure that remains on the Northeast Corridor is not meeting the orientation goals of the park service or the demands of current visitation. Many of these challenges indicate that a thorough reevaluation and redesign of the area is needed. These following results provide data that is crucial to redesigning the pull-offs on Northeast entrance road to better foster positive and compliant visitor behavior.

Descriptive Results

Infrastructural Inventory

As described in the literature review, by observing both the **landscape** and the **humans** that inhabit it, one can begin to understand the history, use, and human connection to that space. The purpose of this inventory was to assess the current infrastructure and usage conditions at the study sites, investigate signs of visitor use, and identify recurring behaviors such as social trails and edge effects. These findings provide insights into design measures described in phase two of the thesis to minimize visitor impacts. The information was cross tabulated visually to examine the distribution of conditions and infrastructure across the sites (Fig.9).

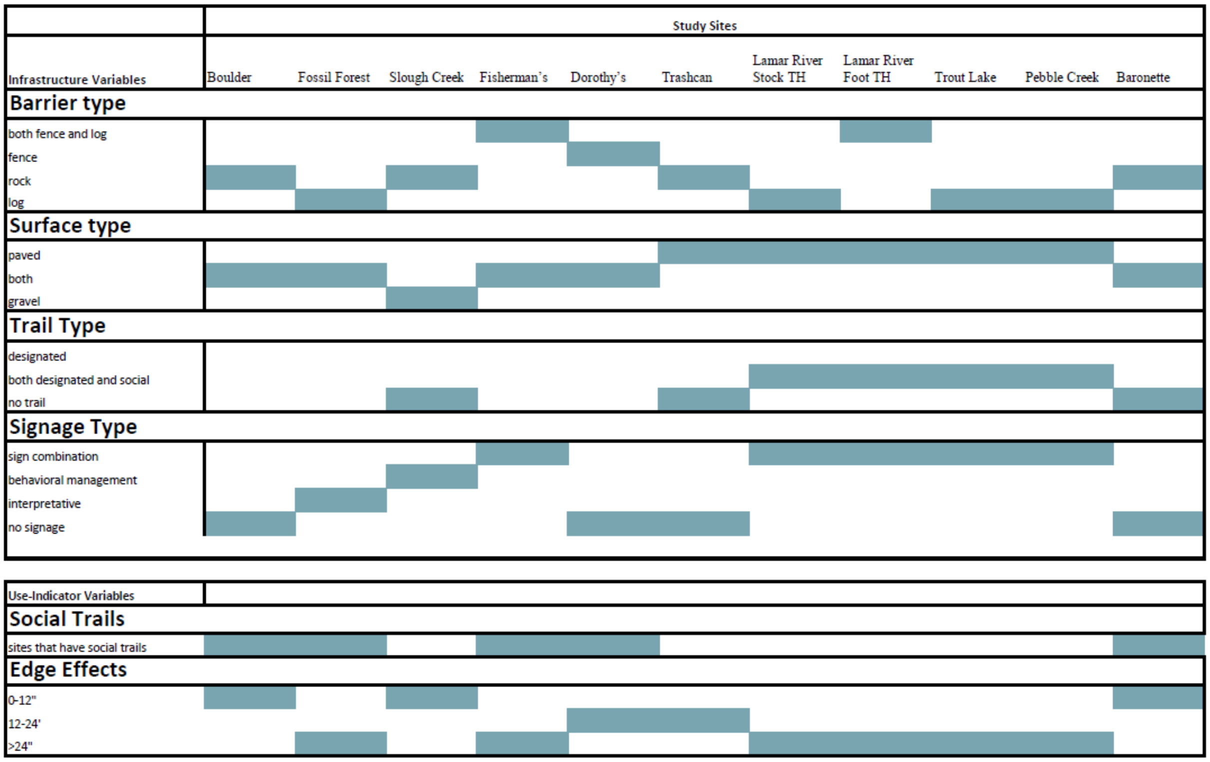


Figure 9 Visual Cross Tabulation of Infrastructure and Use Indicators

Barrier Types

Barrier types were categorized as follows (Appendix C):

1. **Rocks**: Rocks or boulders ranging from 6 inches – 36 inches that are intentionally placed around the perimeter of pull-offs. Rock sizes range across the sites.
2. **Fence**: Wooden log, split-rail fencing that is between 24 inches - 48 inches high, depending on the subtype of fence
3. **Logs**: 6-inch-high logs placed at the edges of pull-out perimeters
4. **Fence-Log combination**: a combination of both the 6-inch-high log and a subtype of split-rail fencing.

All eleven sites have some type of barrier. There are a total of eleven study sites. The frequency distribution of barrier types across study sites indicates that barrier types are bimodal, with four sites having rocks, and four having logs. There are four categories of barrier types: The bimodal distribution at a frequency of four indicates that there is moderate consistency in barrier types (Fig.10).

Barrier Type	Frequency (f)
Fence and Log	2
Fence	1
Rock	4
Log	4
N=11	

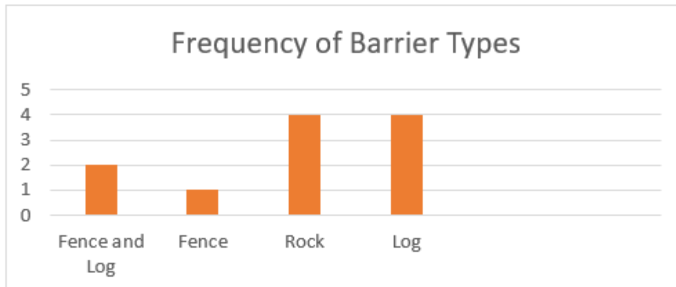


Figure 10 Frequency Distribution and Corresponding Bar Chart of Barrier Types

Surface Types

Surface types were categorized as follows:

1. **Paved**: Site has been overlaid with an agglomerate, or fixed aggregate
2. **Loose Aggregate:** Site has rocks or gravel surface that is not fixed.
3. **Combination of Paved and Loose Aggregate:** Site has sections of surfaces that are agglomerate and some that are loose.

The frequency distribution of surface types is also bimodal, with five sites having a paved surface, and five of them having a combination of gravel and paving (Fig. 11).

Surface Type	Frequency (f)
Paved	5
Combo of Both	5
Loose Aggregate	1
N=11	

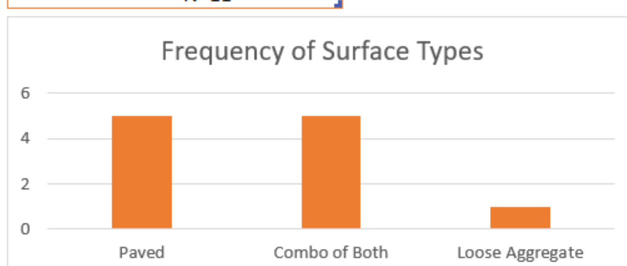


Figure 11 Frequency Distribution and Corresponding Bar Chart of Surface Types

The bimodal distribution of surface types indicates that most sites are either fully paved, or partially paved. The high frequency of category 3 may convey that park personnel need additional space for parking due to high visitor volume and demand for parking, and therefore they currently lay down loose aggregate as an additional parking surface.

Trail Types

There are four categories of trail types:

1. **Designated Trails**: Trails that are maintained by the park service and that are included in visitor-media materials.
2. **Social Trails:** Social or 'desire paths' are informal trails that are not maintained by the Park Service and are created by a high frequency of visitors using the path.
3. **Designated Trails accompanied by Social Trails**: Trails that are maintained by the Park Service and trails that are created by visitors through repeated use (described later under use inventory).
4. **No Trails**: No trails were present.

Trail Type	Frequency (f)
Designated	0
Combo of Both	4
No Trail	3
Social Trail	4
	N=11

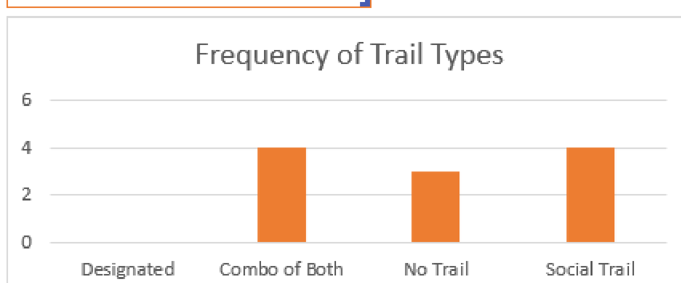


Figure 12 Frequency Distribution and Corresponding Bar Chart of Trail Type Categories

The frequency distribution was unimodal, indicating that most sites have a combination of both designated and social trails (Fig.12). There were two sites that had no trail presence. There were no designated trails that did not have social trail (category 1). The absence of designated trails unaccompanied by the presence of social trails in conjunction with a high frequency of social trails suggests an inadequacy within the existing trail infrastructure. This may translate to a need for formalized infrastructure that clearly informs visitors where they are meant to walk.

Signage Types

There are four categories of signage types present at the study sites:

1. **Behavioral Management:** This type of signage provides information on actions or behaviors that are considered noncompliant with park service guidelines (i.e., no dogs allowed, conservation zones where visitors are not allowed to walk)
2. **Interpretation:** Signage that interprets wildlife, history, or cultural components of Lamar Valley.
3. **Combination of multiple signage types**: Both behavioral and interpretative signage present at one site
4. **No signage:** No signage was present.

The frequency distribution of signage was unimodal, indicating that the most prevalent signage category was a combination of multiple signage types (Fig.13). This prevalence of multiple types of signage used in conjunction

Signage Types	Frequency (f
Sign Combination	5
Behavioral Management	1
Interpretative	1
No Signage	4
	N=11

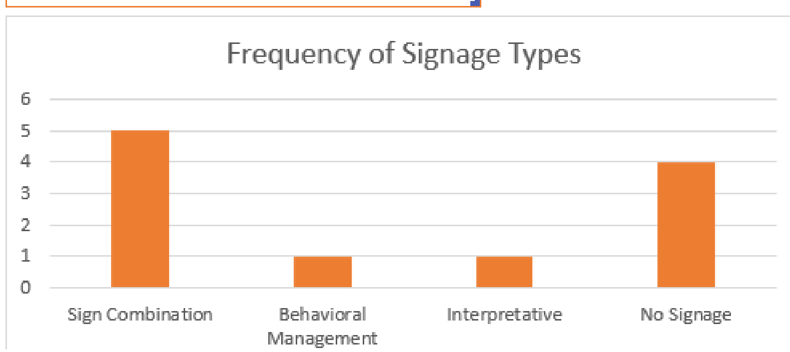


Figure 13 Frequency Distribution and Corresponding Bar Chart of Sign Types

with one another indicates that the park service is moderately consistent with signage and reliant on signage-related communication, indirect management, and interpretation.

<u>Indicator of Use</u>

One category of use-impact was examined:

Edge effects: Vegetation that is worn or damaged along the edges of the pull-outs. Edge effects were sub-typed into three categories based on the width of the vegetation impacted:

1. Width of 0”-12”
2. Width of 13”-24”
3. Width of > 25”

The frequency distribution of Edge effects was unimodal, with six sites having damaged vegetation around the pullouts that is greater than 25 inches wide (Fig.14). This is an indicator of high foot traffic and degradation at the thresholds between natural habitats and human activity that results from people leaving the pull-offs. The high frequency of edge effects at a width of 25 inches and above indicates that keeping people inside of pull-offs should be a priority for the park service to minimize use-impacts on natural resources.

Edge Effects	Frequency (f)
0"-12"	3
13"-24"	2
>25"	6
	N=11

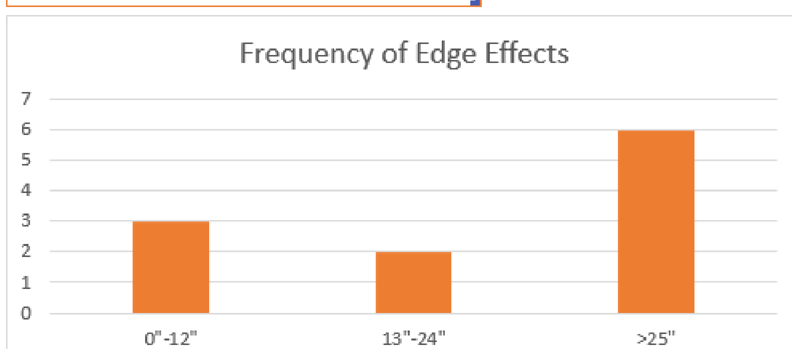


Figure 14 Frequency Distribution and Corresponding Bar Chart of Edge Effects

The inventory analysis indicates that the existing infrastructure at the study sites shows consistency in the use of barriers, surfaces, and signage. However, the presence of social trails and edge effects suggests a need for more defined trail systems, visitor guidance, and improved infrastructure to manage and protect these areas effectively. The data provides valuable insights into the behaviors and preferences of park visitors and suggests potential areas for improvement in design to manage visitors leaving pull offs and using infrastructure as indirect management in conjunction with signage.

Visitor Observations

A total of 1,435 visitors were observed across 258 observations. On average, six visitors were present per observation. The 258 total observations were equally distributed across the eleven sites, and each site had between 22-24 observations.

Summary statistics indicated that 434 of the 1435 total visitors approached wildlife (Fig.15). The site with the highest visitor count is "Lamar River Foot" with a count of 258

Descriptive Statistics of the Total Visitors Observed in Sample

	Observations	Sum of Visitors	Mean	Std. Deviation	Variance
Visitors Observed	258	1435	5.56	8.257	68.177
Valid N (listwise)	258				

Figure 15 Descriptive Statistics of Total Visitors Present in Sample

visitors in 24 observations and an average of 11 visitors per observation. The site with the second highest visitor count is "Fossil Forest" with 218 visitors across 22 observations, for an average of 10 visitors per observation.

Of the 1,435 total visitors, 434 of them were observed to approach wildlife (Fig.16 and 17). The site with the highest count of visitors approaching wildlife was "Fossil Forest" with a count of 128 visitors.

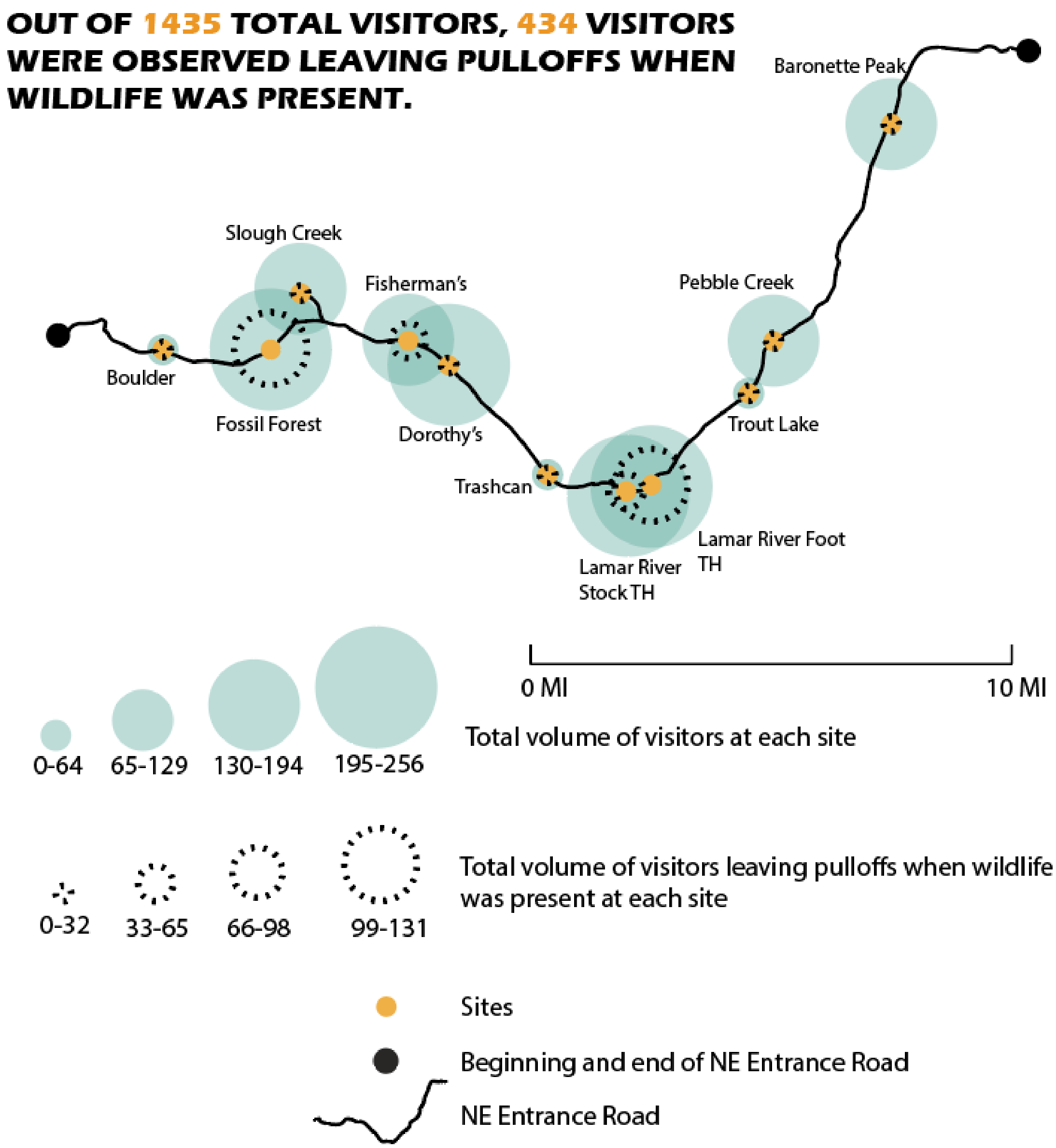


Figure 16. Spatial Visualization of Visitors Leaving Pull-offs When Wildlife was Present

Site	Elevated Viewing	Wildlife Approach	DB:Smartphone Camera	DB: Point and Shoot Camera	DB: DSLR Camera	DB: Spotting Scope	DB: Binoculars
	Counts of Visitors engaged in wildlife Viewing Behaviors						
Boulder	2	6	1	.	.	.	3
Fossil Forest	5	128	3	2	5	34	20
Slough Creek	11	20	2	.	3	34	20
Fisherman's	4	50	11	.	9	5	29
Dorothy's	15	32	8	1	5	32	38
Trashcan	8	18	2	.	6	4	11
Lamar River Stock TH	9	62	6	1	2	1	13
Lamar River Foot TH	14	100	6	.	2	15	18
Trout Lake	.	2	1	.	.	1	.
Pebble Creek	3	0	2	3	6	18	4
Baronette	2	16	4	1	5	12	29
Total of visitors performing Behaviors	73	434	46	8	43	156	185
N=1435							

Figure 17 Frequency Distribution of Wildlife Viewing Behaviors per study site

Out of the 1,435 total people, the most prevalent device-based wildlife-viewing behavior observed was the use of binoculars, with a count of 185 visitors using this device (Fig.17). The second most observed device-based viewing behavior was the use of spotting scopes, with 156 people counted using them (Fig.17). Of the 1,435 people observed, 77 of them were observed to be engaged in behaviors to elevate themselves by climbing infrastructure to seek another vantage point for wildlife-viewing (Fig.17).

There was a total of 945 out of 1435, or 66% of observed visitors were engaged in wildlife viewing behavior of some kind, indicating that these behaviors are frequent at these sites in Lamar Valley. Designing spaces that optimize safe wild-life viewing behaviors such as device-based viewing from a safe distance, and minimizing wild-life approach behaviors should be a major design consideration.

Inferential Results

Research Question: Is there a difference between the means of visitors approaching wildlife based on the type of barrier present at roadside scenic pull-offs in Yellowstone National Park?

After determining that the data was nonparametric, a comparison of the means of visitors leaving pull-offs when wildlife was present for each barrier type was completed. The highest average observations of visitors crossing barriers when wildlife was present occurred when the barrier type was "fence-log combination" (Table 2.). A Kruskal-Wallis test indicated that there was are statistically significant differences in wildlife approach behavior among the four different barrier types (Table. 3). The test statistic of 23.237 and a small p-value (0.001) together support the conclusion that the wildlife approach behavior is different across barrier

Means Comparison of Visitors Approaching Wildlife Across Barriers

added all counts of visitors approaching all species types

categorical boundaries	Mean	N	Std. Deviation
rocks	.6383	94	1.65166
logs	2.1064	94	8.01808
fence	1.3913	23	2.87211
fence_log_combo	3.1915	47	4.53315
Total	1.7054	258	5.43358

Table 3. Mean comparison of visitors approaching wildlife across barriers

Independent-Samples Kruskal-Wallis Test Summary

Total N	258
Test Statistic	23.237[a]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	<.001

Table 2. Kruskal-Wallis Test Summary

types. A hypothesis test indicated that the null hypothesis was rejected by a one-tailed significance level of 0.001 (Table. 4). This further supports that there is a statistically significant difference in the number of visitors approaching wildlife across barrier types.

To determine which specific barriers were significantly different from one another, post hoc analysis was done with a pairwise comparison test. The pairwise comparison revealed a statistically significant difference in mean visitor approach counts between two separate barrier

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of visitors approaching wildlife is the same across categories of barriers	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Table 4. Hypothesis test summary Indicates that the null hypothesis was rejected with less than .001 significance.

combinations (Table. 5). The first is between the rock barrier type and the fence/log combination barrier (p value 0.001), with the fence/log barrier type exhibiting a notably higher average count of visitors approaching wildlife. The second significant difference in visitor approach was between the log

Pairwise Comparisons of Approach Behavior Across Barrier Types

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
rocks-logs	-4.495	8.251	-.545	.586	1.000
rocks-fence	-13.060	13.158	-.993	.321	1.000
rocks-fence and log combo	-46.404	10.105	-4.592	<.001	.000
logs-fence	-8.565	13.158	-.651	.515	1.000
logs-fence and log combo	-41.910	10.105	-4.147	<.001	.000
fence-fence and log combo	-33.345	14.394	-2.317	.021	.123

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table 5 Pairwise comparison indicates a significant difference in visitor approach observations between two sets of barrier types (fence-log combo and rocks) and (logs and fence-log combo)

barrier type and the fence/log combination type (p value = 0.001) with the fence/log barrier type exhibiting a higher count of visitors approaching wildlife.

The results of the inferential analysis indicate that there is a significant difference in observations of visitor-approach across the barrier types present at pull off on Northeast Entrance Road between the following barrier types:

1. **Between Rocks and Fence-Log Combination:** There is a significant difference in observations of visitors approaching wildlife between the presence of rocks, and the presence of both a fence and log. The presence of rocks had less wildlife approach behavior observed, which is interesting because it is a less formal type of boundary than a fence and a log.
2. **Between Log and Fence-Log Combination:** There is also a significant difference in observations of visitors approaching wildlife between the presence of the log barrier type, and the presence of both a fence and log. The presence of fence-log combination had less wildlife approach behavior observed. I speculate that this may have to do with the space seeming more formal and designed for humans, thus acting as cues to visitors that they should not approach wildlife and that they should instead stay in their designated area.

Based on the results of the Kruskal-Wallis test, I would speculate that the wildlife approach behavior had less to do with the barrier type, and more to do with the wildlife present at the sites and the many other spatial and sociological confounding variables that influence wildlife-approach. It is truly inconclusive whether there is a significant difference in the behavior based on barrier type due to the bivariate nature of the analysis, and the intention-behavior gap, which indicates that one cannot understand an individual's behaviors without understanding their intentions (Hassan, 2016).

Limitations and Implications for Research

It is essential to note that while the analysis demonstrates a statistical difference in wildlife approach behavior across barrier types, it is inconclusive regarding whether the barrier type itself was the variable influencing visitor behavior. The significant result could be attributed to various other factors or confounding variables that were not considered in this study such as the wildlife species type, quantity, and distance from the barriers. Furthermore, the sample size of this study was smaller than anticipated, weakening the overall statistical analyses.

There are also limitations in the unobtrusive observational methodology of this study in relation to the intention-behavior gap. However, additional future research that further explores the many spatial and sociological factors that influence wildlife behavior may provide more concrete evidence that infrastructure influences wildlife-approach behavior. One component of future research that would be insightful is the use of experimental design methods to test various barrier types efficacy at minimizing wildlife-approach behavior. Another would be to utilize survey methodologies to understand the experience, intentions, motivations, and perception of visitors when they are approaching wildlife in a designed, picturesque space.

While this study could not definitively prove that infrastructure is a key factor in visitors decision-making when approaching wildlife, it did reveal that the current infrastructure, designed with the intent to manage visitor behavior, is not effectively preventing wildlife approach incidents. This preliminary insight suggests that Yellowstone National Park might want to consider allocating funds for the strategic development of new infrastructure aimed at guiding visitor behavior in line with the Park Service's mission. Specifically, this paper will address the challenges posed by visitors approaching wildlife by proposing a design framework that draws from this research and existing behavioral, aesthetic, and design theories. This framework will offer practical, design-based solutions for a high-traffic pull-off site on Northeast Entrance Road in Yellowstone, known as 'Fossil Forest.' This site has witnessed high visitation and observed wildlife-viewing-related behaviors, including wildlife approach, as depicted in Figures 16 and

17. These challenges that arise from these behaviors are amenable through design-based solutions.

Chapter 6 Design Based Solutions That Promote Positive Visitor Behaviors and Decrease User Impacts on Natural Resources

Historically and scientifically, aesthetic experiences arising from picturesque design have been associated with eliciting emotional responses and behaviors, including wildlife-approach behaviors in United States National Parks, as thoroughly described in Chapter two. Therefore, Cues to Social Conduct (CTSC) is a design framework that builds off these findings by utilizing behavioral intervention theories to respond to the following design inquiry:

How can we effectively design spaces that intervene in the emotional and behavioral responses triggered by aesthetic experiences, such as wildlife-approach behaviors in United States National Parks, with the goal of promoting positive visitor behaviors?

Cues To Social Conduct

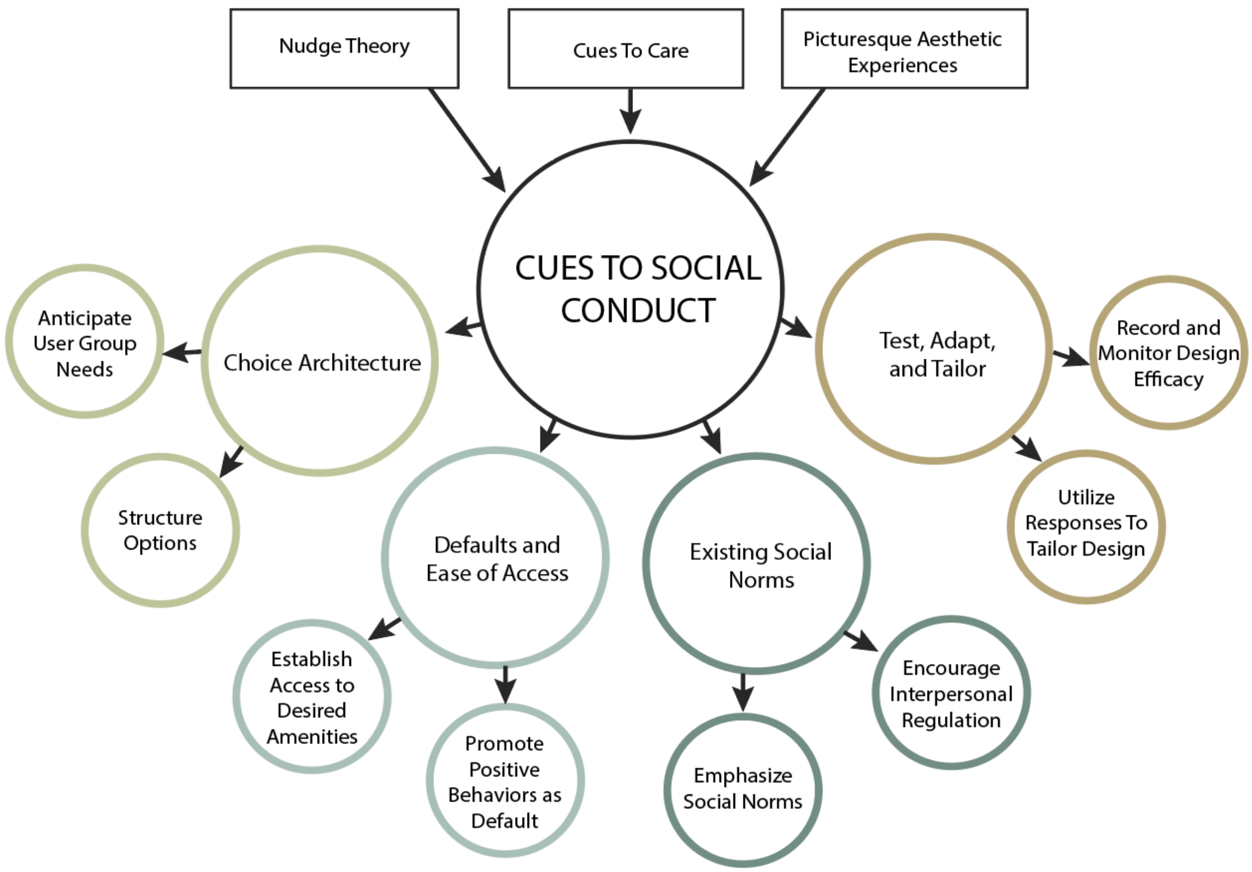


Figure 18 Cues To Social Conduct Framework Diagram Illustrating the Main Theoretical Foundations and Core Framework Elements

Cues to Social Conduct is a landscape-based behavioral intervention framework for designing and evaluating infrastructure as a means of nudging visitor behaviors and managing human-wildlife interactions.

The framework name "Cues to Social Conduct", pays homage to the work of Joan Iverson Nassauer, who developed a socioenvironmental theory called Cues to Care (CTC), where she describes CTC as elements in a landscape that are recognizably designed to indicate that a space is cared for by humans (Li and Nassauer, 2020).

CTSC aims to promote positive wildlife-viewing behaviors in U.S. National Parks by integrating Nudge theory, Cues to Care Theory, and the design of picturesque landscapes (Fig. 18). It utilizes the aesthetic, spatial, and functional attributes of the landscape to guide visitor behavior towards compliance with park regulations. The intended outcome of CTSC is to minimize wildlife approach behavior and visitor impacts on natural resources by using design to clearly communicate to visitors where they are meant to go, and what they are supposed to do. Although the concept of shaping landscapes to influence behavior may initially raise concerns about subtlety and paternalism, using elements like signage, materials, landforms, and vegetation to shape experiences is consistent with long-standing, foundational practices in landscape architecture. In essence, the CTSC reinterprets and applies these landscape design principles under a lens of behavioral intervention, specifically to encourage better wildlife-viewing behaviors in U.S. National Parks.

There are four core elements that guide the design of a space with Cues to Social Conduct (Fig.18):

Choice Architecture: A term that was coined by Thaler and Sunstein to describe the designed environments effect

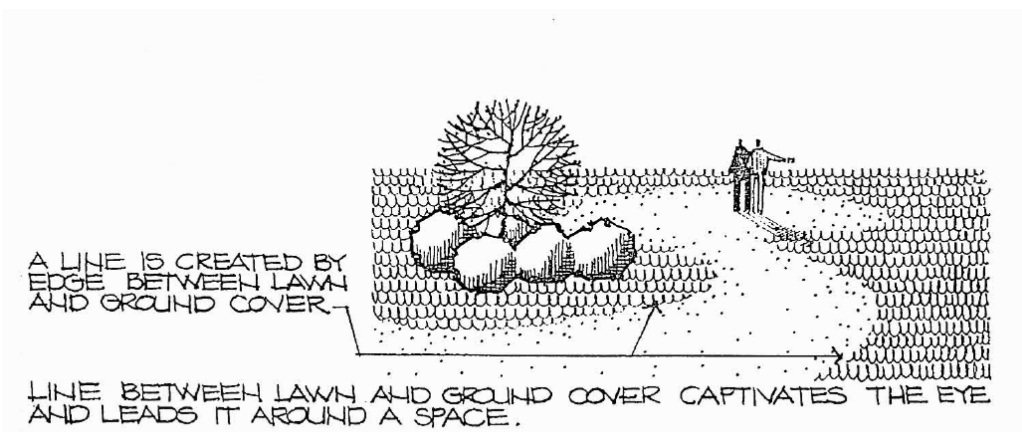


Figure 19 Using the Landscape Palette to Design Choice Architecture. (Booth, 1989).

on the decision-making process of humans, choice architecture is a key component of understanding how to (1) anticipate the needs of user groups, and (2) design environments that structure options, e.g., you can go here or here, but you probably don't want to go there. An example of choice architecture in landscape design is guiding users toward where to go to get to the experiences they want by using topography and vegetation to alter an individual's perception of spatially driven decisions limits (Fig.19).

Defaults and Access:

Figure 21 Subtle arrows designed into a smooth ground material to indicate circulation direction and promote efficiency (Krum 2023).

This element of the framework focuses on designing landscapes that are easy to navigate by establishing easy clear and access to programmed amenities. This, in turn, sets up positive and compliant visitor behaviors as the default. This technique is often done through careful materiality choice, such as the use of directional arrows designed into the ground plane of the Chicago International Airport to direct people where to walk (Fig.20), or the use of material strips in front of metros to direct people where they should and should not stand (Fig. 21).

Figure 20 Carefully chosen materials, and a minor slope indicate where people should and should not stand in metro station (Washington Post, 2021)

Emphasize Social Norms:

Emphasizing social norms is a common practice in the development of protected area signage that can also be done through infrastructural design. Social norms are when individuals in various settings attempt to read the attitudes and perceptions of others in a spatial setting grasp what behaviors are commonly accepted. By anticipating and indicating social norms through the configuration of an environment, a designer can create a landscape that promotes interpersonal regulation, or spaces where people hold each other accountable. This can be an extremely impactful design technique for indirect visitor management. An example of indicating social norms through infrastructural design is the careful placement and height of dune fencing to make negative behaviors awkward to partake in (Fig.22). A well-known example of signage that encourages interpersonal policing is the signs and zones around sea turtle habitat that tell visitors what is happening around them and encourage people to leave turtle hatchlings alone and report misconduct (Fig.23).

Figure 23. Dune fencing used to emphasize social norms, and placed at a height that is awkard to both climb over and under (Dewey Cape, 2023).

Figure 22. Sea Turtle Signage Encouraging Interpersonal Policing as a form of Indirect Management (NOAA, 2022)

Test Adapt and Tailor:

This element of the framework is derived from Nudge theory, and it recognizes that a design tailored to a specific intervention-based functions must be systematically and routinely monitored to determine their efficacy, and areas of improvement. An example of monitoring the use impacts and infrastructural conditions of a designed landscape are studies like the one preceding this chapter. Monitoring the impacts of a design post-implementation is a practice that is not done nearly enough in landscape architecture. Understanding which types of infrastructure designs effectively influence visitor behavior can provide essential feedback for future design and park management practices.

Redesigning Fossil Forest and By Applying Cues To Social Conduct

<u>Existing Conditions</u>

Fossil Forest is located on the western side of Northeast Entrance Road in Yellowstone National Park (Fig.24).

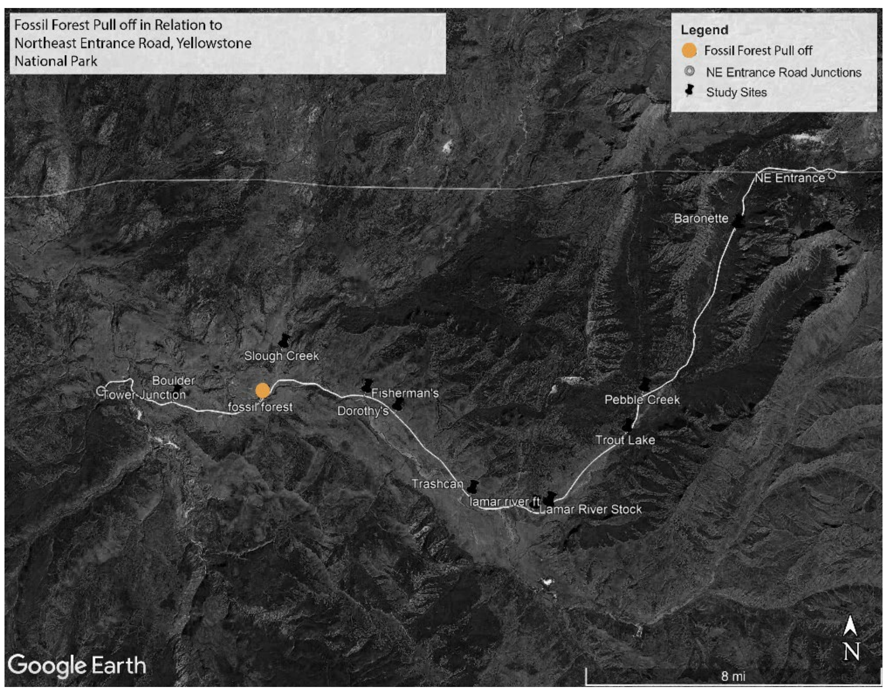


Figure 24 Fossil Forest pull off on Northeast Entrance Road, Yellowstone National Park

Fossil Forest is a site that is a popular pull-off location due to its historical significance and its proximity to a den that is occasionally inhabited with wolves, depending on the season. With a zoom-based viewing device such as a scope or binoculars, individuals can see this den. Historically, this pull off is the closest area in the front-country to view the location where wolves were acclimated to Yellowstone National Park in 1995. From the pull off, visitors can see one of the locations where the wolves were brought and acclimated to their new environment in pens (Fig.25). In addition to its historical significance, Fossil Forest currently provides access to an unmaintained trail called "Specimen Ridge" that is frequently misinterpreted as a park-designated trail due to the trail's media presence and the trailhead signage that exists before the pull off coming from the western direction (Fig. 26).

Figure 25 . Fossil Forest is a popular location to see where wolves were reintroduced to Yellowstone National Park (Yellowstone Park Coalition, 2022).

Figure 26 Misleading trailhead signage at Fossil Forest pull off. Google Earth, 2023.

The existing infrastructure at Fossil Forest includes a paved parking surface with a six-inch high log tracing its perimeter (Fig.27). There is an interpretive sign describing the site's historical significance, there is a social trail extending outward toward the undesignated Specimen Ridge Trail. The previous study found that Fossil Forest has high user impacts, with edge effects at greater than 25" wide. This is caused by pedestrian and vehicular traffic volume that is higher than what the current infrastructure can hold (Fig. 28 and 29). Fossil Forest currently has space for eleven vehicles to park within its boundaries.

Figure 27 Six-Inch high log barrier around the perimeter of Fossil Forest

Figure 28. Edge effects wider than 25 inches caused by pedestrian traffic at Fossil Forest pull off

The site is popular for wildlife viewing, and the previous study indicated that Fossil Forest has high counts of wildlife approach (128 visitors observed approaching wildlife) and moderate counts of visitors utilizing existing topography to seek better views of the scenery and wildlife (Fig.30).

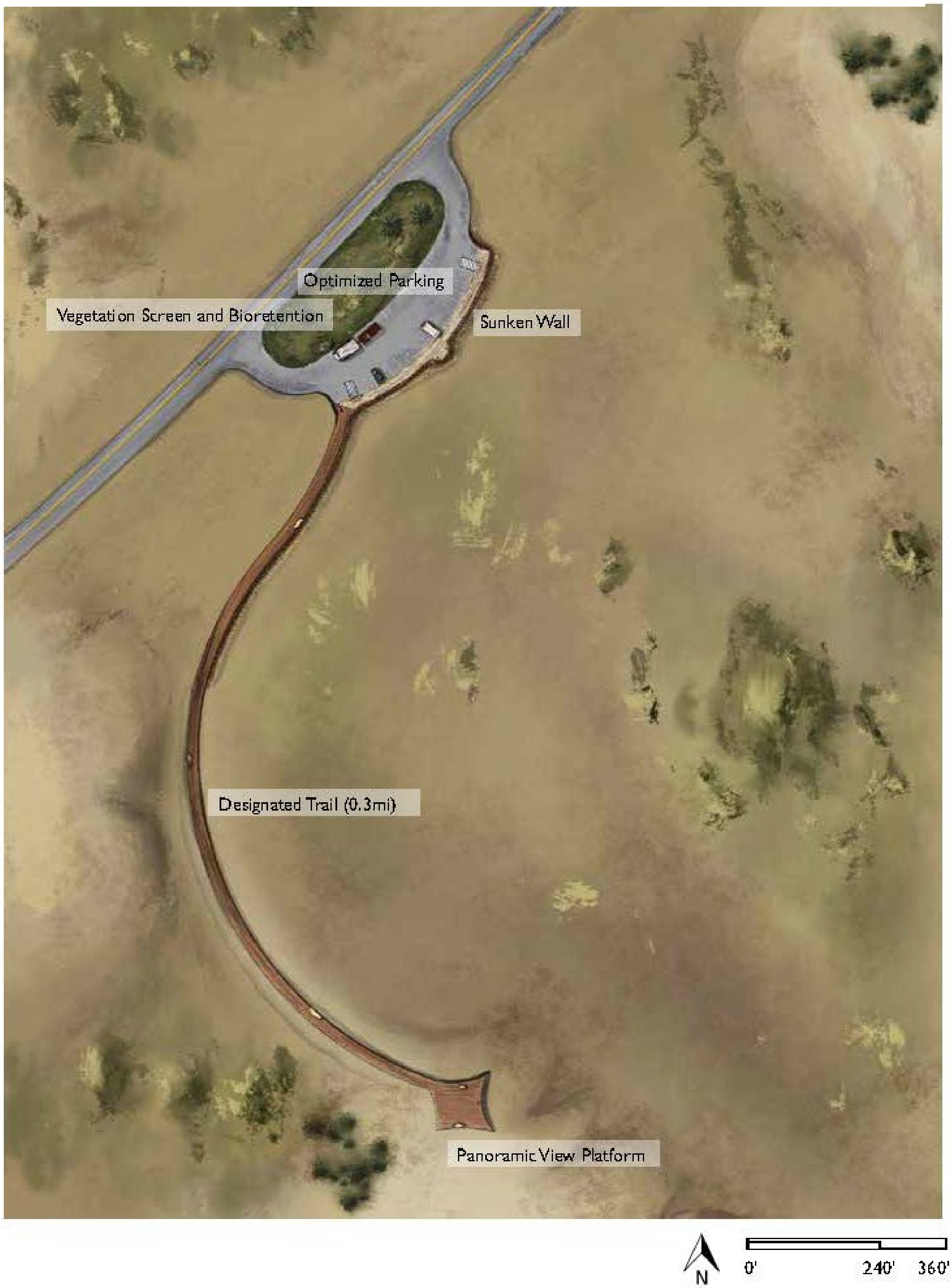
Figure 29 Edge effects wider than 25" caused by Vehicular Traffic and noncompliant parking behaviors at Fossil Forest

Figure 30 Visitors directly adjacent to Fossil Forest seeking elevated ground to view wildlife

SPECIMEN RIDGE PULLOFF AND OUTLOOK

Fossil Forest Pullout Reimagined

Figure 31 Plan View of Fossil Forest Pullout redesigned as Specimen Ridge Scenic Outlook and Pull off



The redesign of Fossil Forest is titled “Specimen Ridge Scenic Outlook and Pull off”. The name “Fossil Forest” was informally given to the pull off. Since it has no official name, the first order of design-business was to give it one. I named it after the 8.5-mile ridge of the south rim of the Lamar Valley that the site overlooks, and where wolves were reintroduced.

Figure 32 Fossil Forest Pullout next to its redesign titled "Specimen Ridge Pull off and Scenic Outlook

The overall design intent for Specimen Ridge Pull off and Scenic Outlook is to maintain the site’s existing character and uses while spatially reconfiguring and improving the areas of the site that are more prone to non-compliant visitor behaviors and negative impacts on natural resources such as the pull off edges, and the social trail.

Applying Cues to Social Conduct to Specimen Ridge Pull off and Scenic Outlook (Specimen)

Choice Architecture at Specimen

As stated previously, choice architecture is designing environments that (1) anticipate the needs of user groups, and (2) design environments that structure their options. In other words, who are the user groups of Specimen, what are their needs, and what choices need structured to minimize wildlife approach through design?

By spending ample amount of time in the field interacting with visitors, I learned that there are various subcultures and types of visitors within Yellowstone, even more specifically within the visitors of Lamar Valley. The following primary visitor-types and prevalent wildlife species are primary users of Northeast Corridor. For the design of Specimen to be effective at managing behavior, it must understand the user groups that exist within a landscape and be highly in tune with their needs (Fig..33).

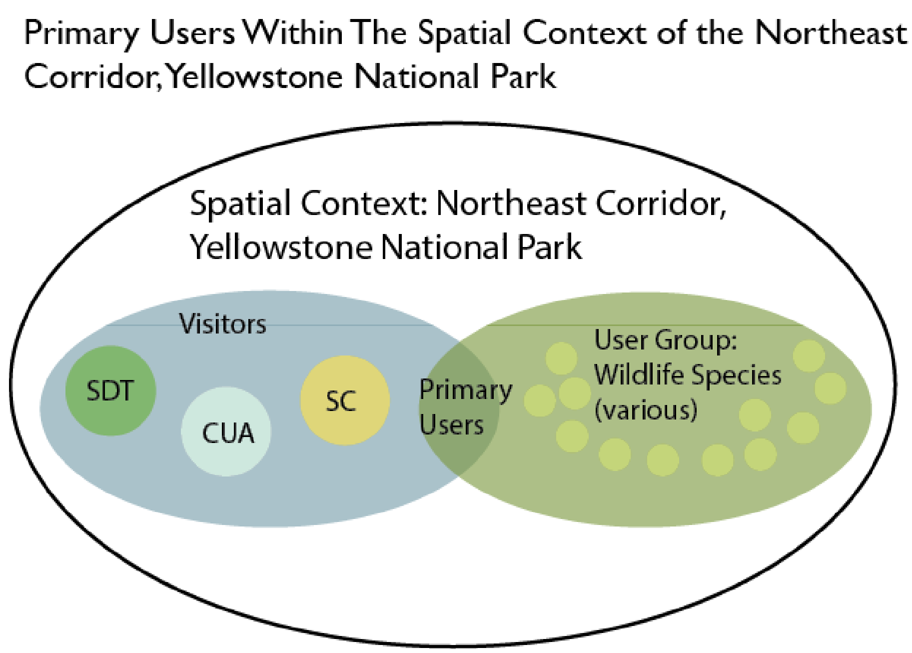


Figure 33. Designing Choice Architecture to be in tune with the needs of the user groups and how they exist within a spatial context: the landscape of the Northeast Corridor

- **Citizen Scientists and Recurring Visitor Groups (e.g., Wolf Watchers, photographers, volunteers)**

  These recurring visitors are dedicated to wildlife viewing and have a strong culture and community within the Northeast Corridor. Their Interests are specified and include citizen science, viewpoints of wildlife habitat, scope-use, tracking and imagery.

- **Self-directed Tourists**

  This subsection of tourists includes visitors who are temporarily visiting Yellowstone and are directing themselves through the Northeast Corridor seeking wildlife viewing experiences, beautiful panoramic views, trails, and worthwhile experiences.

- **Commercial Use Authorizations (CUA)**

  Many touring companies are run by community members who live in the gateway communities of Yellowstone, and they operate tours year-round. Many of the tour operators are closely linked to park personnel personally. If tour operators and park personnel interests are aligned, these operators play a crucial role in providing direct management to tourists with which they are working for- advising positive wildlife viewing behaviors and park stewardship.

- **Various Wildlife Species**

  Wildlife is another- if not the primary- user of Specimen that must be considered when designing choice architecture. However, this user group cannot speak for itself. It is believed that increasing the distance between humans and wildlife is of their best interest.

For the Citizen Scientists, I understood that their needs were tied to traditions, and I designed a formalized wildlife-viewing nook in the exact location where they set up their scopes. By designing a space that is formalized and personalized to their needs, it continues traditions, creates investment in the site, and gives them the option to choose a formal space over informal areas (Fig. 34).

Figure 34. Visualization hand-sketch of a Wildlife Viewing Nook for User groups at Specimen Ridge Pull off and Scenic Outlook

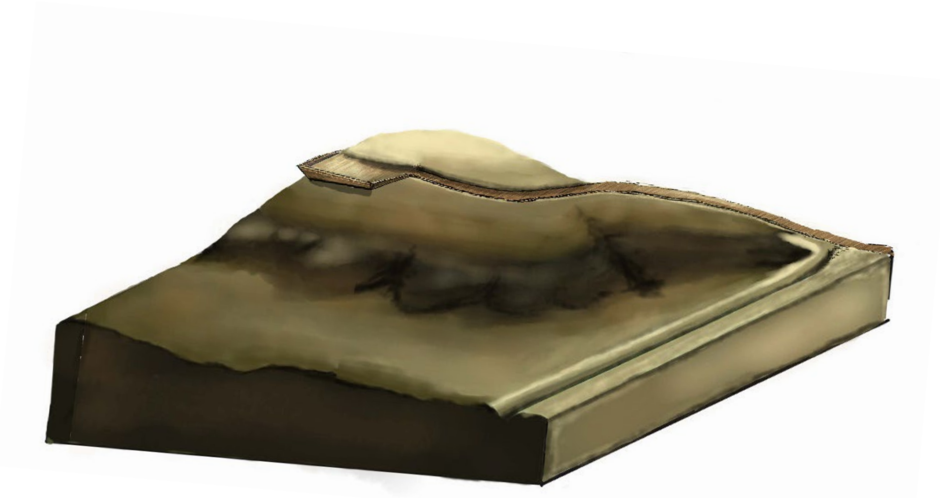


Figure 35 Axonometric view of the scenic trail (0.3 mi) that extends from Specimen, promptly ending at a panoramic viewing platform.

For self-directed tourists, their motivations are tied to accessing novel and worthwhile experiences, some of which include hiking, seeing wildlife and picturesque scenery, and creating memories that are tied to the landscape. Therefore, I utilized the existing topography of Specimen to locate a trail that follows the ridge of the hill adjacent to the pull off. The trail

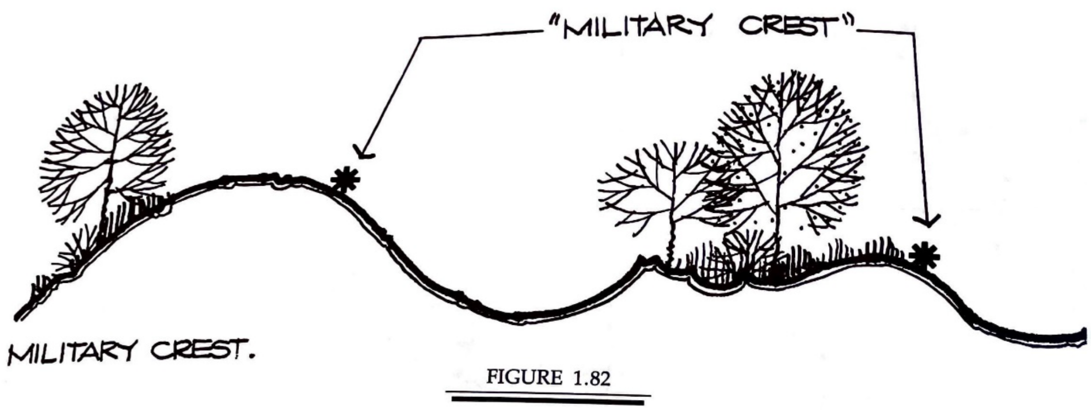


Figure 36. Section view of a military crest, a common location to design a structure that blends into a slope (Booth, 1989).

promptly ends at a viewing platform on the military crest of the hill, facing outward toward Specimen Ridge (Fig.35 and Fig.37) A military crest is a historical term for the point near the crest of a convex landform that provides an ideal vantage point for panoramic views, an area that was historically vital in military defense (Booth, 1989) (Fig. 36). By creating a pathway that sweeps across the landscape, choreographed to end at a viewing platform with expansive and elevated views of specimen Ridge, it utilizes aesthetic experiences including sublime and picturesque in a structured, rhythmic way. In doing so, the design promotes positive, on-trail exploration behaviors and it directs visitors toward a choreographed, memorable experience.

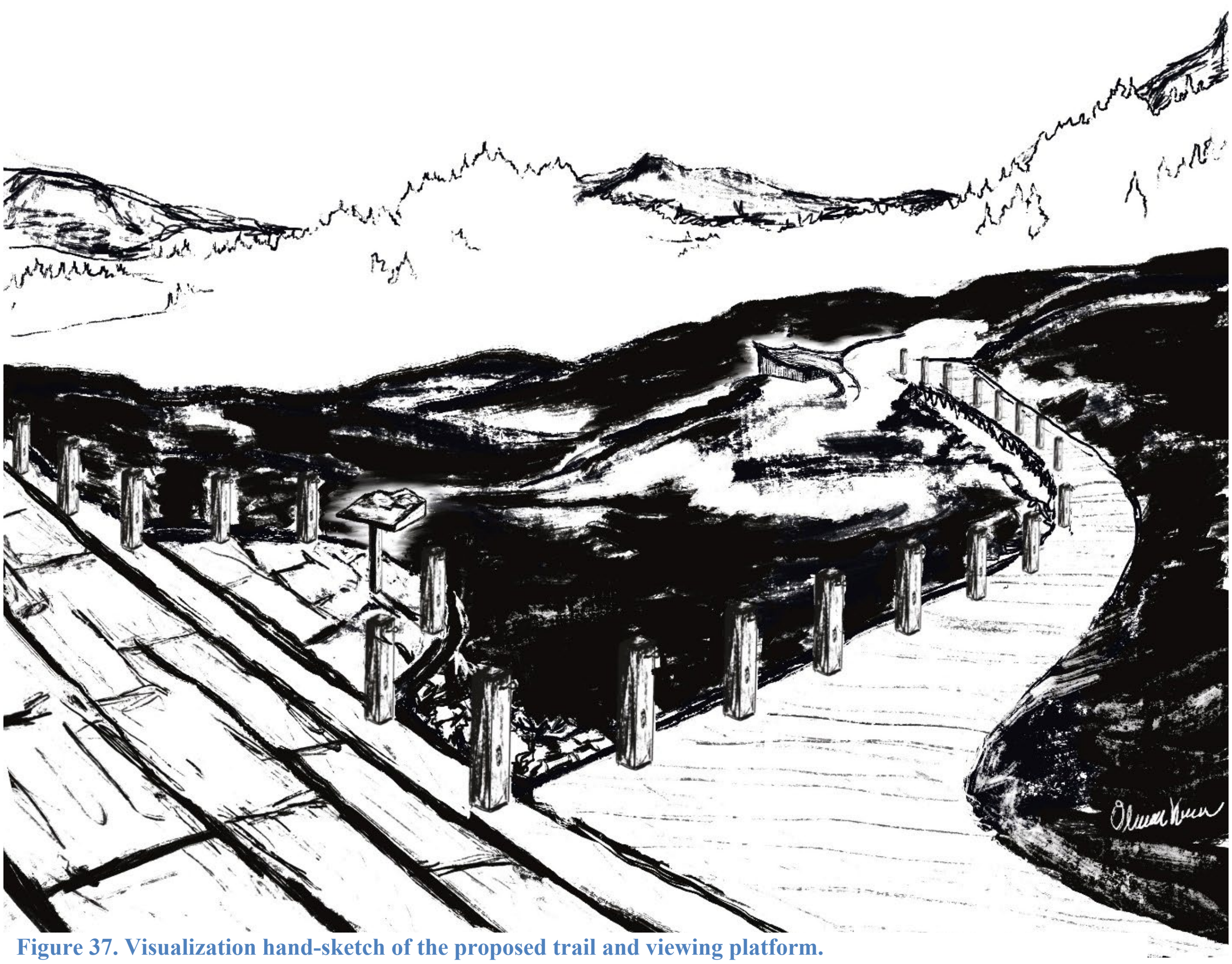


Figure 37. Visualization hand-sketch of the proposed trail and viewing platform.

The viewing platform itself is also designed to encourage sublime aesthetic experiences. Its unorthodox shape and curved ground plane establish a sense of uncertainty where visitor's walk, promoting caution and awareness that encourages safe behaviors, therefore further structuring behaviors. (Fig.38 and Fig.39)

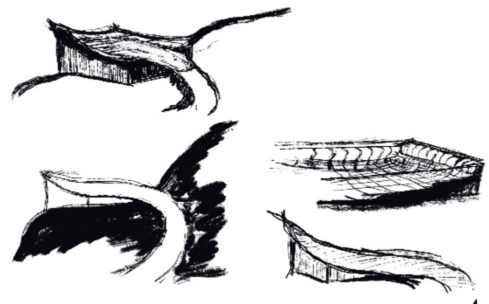


Figure 38. Conceptual Design Vignettes of an unorthodox scenic viewing platform

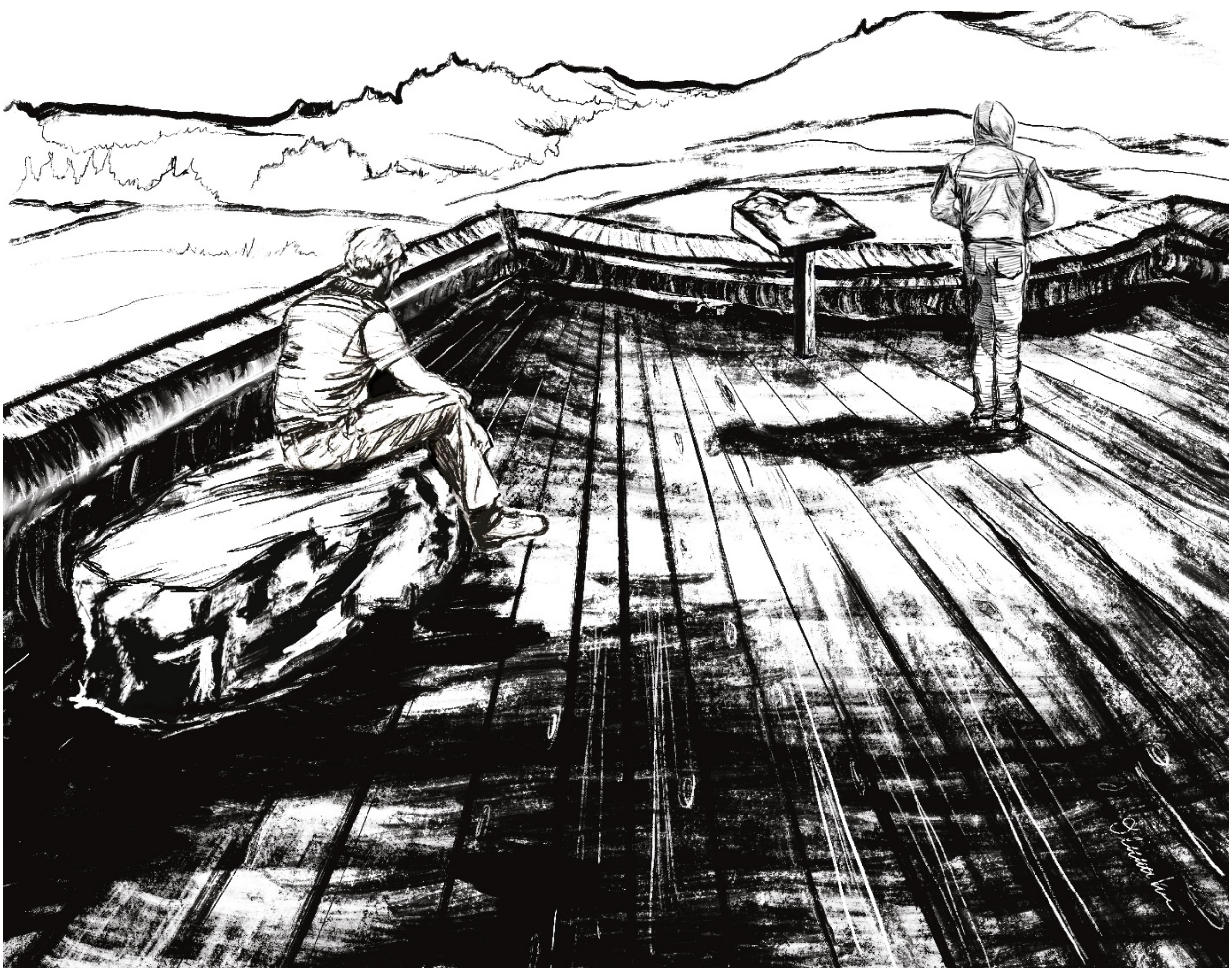


Figure 39. Visualization hand-sketch of a view of Specimen Ridge from the proposed viewing Platform

Designing Specimen to incorporate the needs of CUAs included incorporating vegetation to screen the pull off. During conversations with tour guides, they emphasized that a common problem is that there is no privacy in wildlife viewing, and little is left to chance. They described that a common occurrence is that self-directed visitors will see their tour vans, and promptly pull into the pull-offs and ask to use their equipment. To ease this challenge for CUAS, and to help provide quality experiences for paying visitors, I reconfigured the pull off to have a vegetated bioretention area that is strategically positioned to screen the view of the pull off from the road.

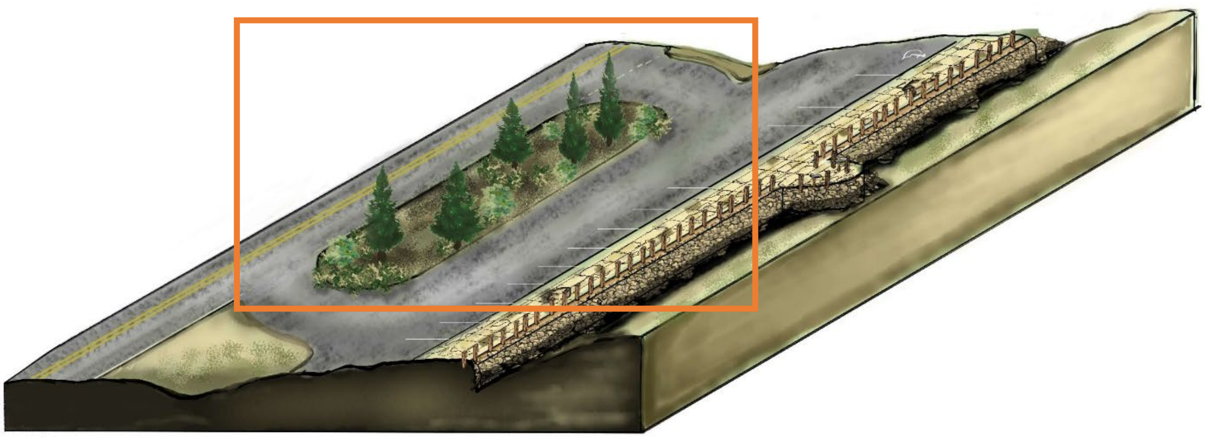


Figure 40. Axonometric View of Specimen highlighting the use of vegetation as a screen to minimize visitor-clumping.

Designing for CUAs also included spatially configuring the pullout to include parking spots that are designed as quick pull-in spots for their vans, and for emergency personnel if needed (Fig. 41). This structures the parking and visual options of visitors to minimize traffic-based issues and resulting impacts edge effects.

Figure 41. Zoomed in plan of the Specimen Pull off parking area highlighting the quick pull-in spots for CUA vans.

The design of choice architecture for wildlife is a dual-sided design that seeks to increase the distance between wildlife and visitors both horizontally and vertically. The intervention is called a sunken wall, coined the "Haha" in 18th century English landscape design for the laughs that would result from its optical illusion-effect to disappear (Booth, 1989). The abrupt topographical depression and steep slope provides clear views of scenery but decreases the likelihood that either humans or wildlife would go near it, either in fear of entrapment, or because it is not the easiest route (Fig. 42). A Haha will follow the edge of the Specimen pull off, acting as a hidden barrier between humans and wildlife (Fig. 44).

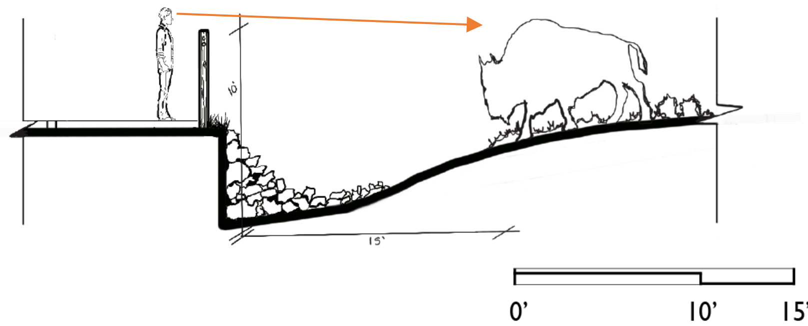


Figure 42. A Haha wall used at Specimen as dual-sided choice architecture for both humans and wildlife

.

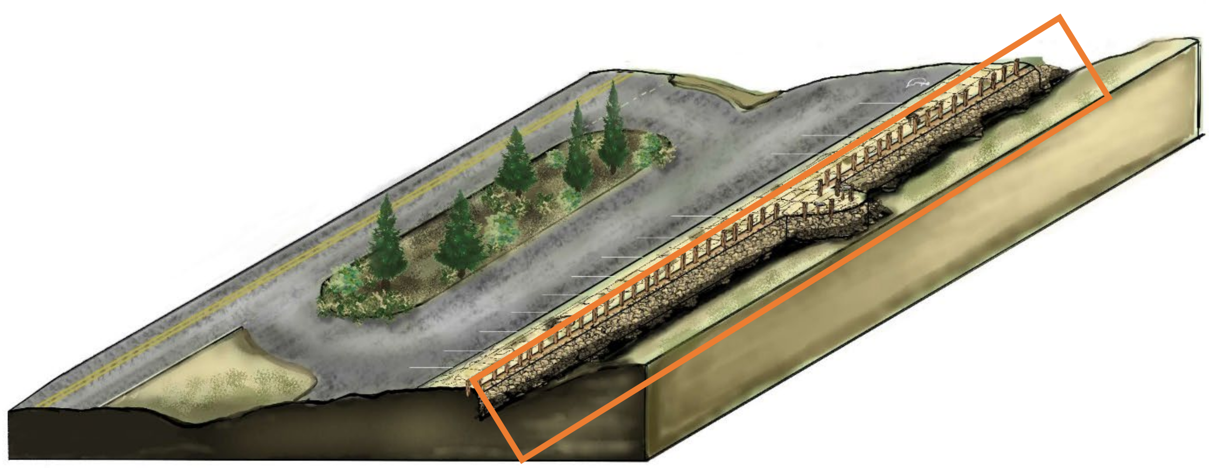


Figure 43. A Haha depicted spanning the length of the Specimen parking area in axonometric view

Creating Defaults and Access at Specimen

Designing ease of access and promoting positive behaviors at Specimen is done through careful choice of materiality and furnishings.

To promote seamless access from parking to wildlife and scenic viewing, a layered system of materials that are flush with one another will be used to indicate to visitors where to go without the need for additional signage or curbs that traditionally delineate space in pull offs (see metro example Fig.21, and Fig. 44). The change in material registers as a stopping point, alerting visitors of the grade change from the sunken wall. The materials that are used blend seamlessly with the environment of Lamar Valley, using sandstone pavers as a nod to the region's geologic history, and a strip of lacquered wood that continues the existing national park, rustic aesthetic with a modernized flare, and rough sandstone boulders that are unsteady, deterring visitors from going down the Haha depression.

Figure 44. Ease of access: a system of layered, flush materials serving as a cue to visitors where to go.

To encourage positive behaviors as the default, furnishings that are specifically designed to rest on will be placed carefully around the site, deterring visitors from sitting on or leaning against fencing or other infrastructure.

Figure 45. Hand-sketch of a sandstone sitting boulder.

Emphasizing Social Norms at Specimen

Signage and fencing are the primary mechanisms used at Specimen to emphasize social norms and encourage interpersonal regulation and indirect management. Derived from the design of dune fencing previously described (Fig. 23), 2-inch-thick manila rope affixed to 5-foot-tall wooden rails will be strategically placed around the perimeter of Specimen and the trail leading to the viewing platform. As the rope curves between the fence poles, it will fall at a strategically awkward height for most adults and some children to crawl over or under (Fig.46). The use of rope as a barrier does not block the scenic views and blends into the environment. The rope is also less likely to create a false sense of security than the use of a wooden fence, encouraging sublimity and reminding visitors they are in a wild habitat. Signage that indicates to visitors why they are not supposed to cross the threshold will be affixed to the manila rope (Fig. 46). The design is intended to clearly indicate what behaviors should and should not be occurring. If people see the signage and people crossing the barrier, they may be more likely to intervene and report non-compliant behavior. Additionally interpretive signage that explains the significance of the area will be placed in parts of Specimen where groups of visitors are meant to gather, such as on the viewing platform (Fig. 39 and Fig.46).

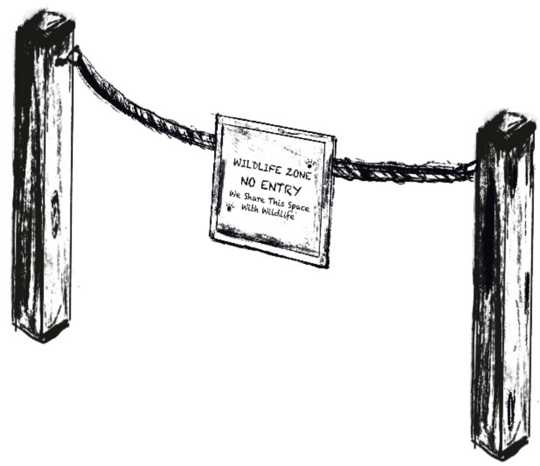


Figure 46. Hand sketch of an unobtrusive rope and rail fencing that is strategically designed to be awkward to cross.

Figure 47. Hand sketch of a three-dimensional interpretive map of Specimen Ridge affixed to a wooden pole.

When these three core elements of Cues to Social Conduct are combined, they create a design for Specimen Ridge Pull Off and Scenic Outlook that is nuanced to nudge visitors toward partaking in park compliant wildlife-viewing behavior, and ready to be tested and monitored (Fig. 47).

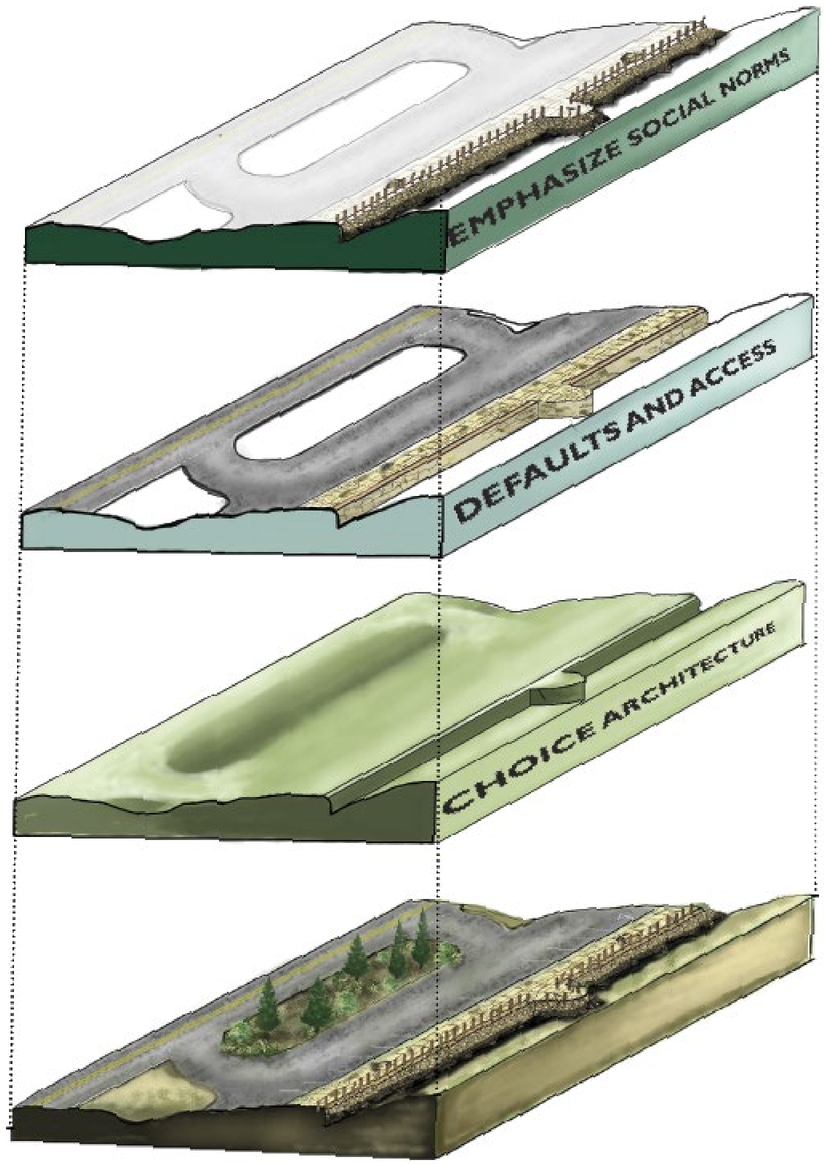


Figure 48. Layering Cues to Social Conduct at Specimen through spatial layout, materiality, strategic vegetation placement, and furnishings

Test, Adapt, and Tailor at Specimen

The study that was completed as part of the analysis for this design served as a preliminary data collection, at the beginning of a larger timeline. Through systematic implementation of this infrastructure over a 17-year timeline, monitoring the various phases impact on influencing visitor behavior can produce data will improve the future phases, tailoring the design specifically to the needs of the user groups at Specimen.

Chapter 7 CONCLUSION

This thesis yields substantial implications for the future design and management of national parks. The current park infrastructure, originally conceived during the Mission 66 era, has become increasingly inadequate in addressing the complex challenges faced by modern national parks. The dramatic increase in visitation and the rising occurrences of human-wildlife conflicts underscore the pressing need for a comprehensive reevaluation of park design and management strategies.

The National Park Service must adapt to effectively balance the crucial goals of resource preservation and public enjoyment, while also addressing contemporary conservation and visitor management objectives. The findings and insights presented in this thesis represent the crucial first steps towards a more profound understanding of the intricate relationship between visitor behaviors and park infrastructure. By grasping this link, it becomes possible to envision and implement design solutions that cater to the evolving needs of park visitors while preserving the ecological and cultural integrity of these landscapes for future generations.

In an era where ecological sustainability and the harmonious coexistence of wildlife and humans are paramount, it is imperative to explore innovative design typologies and strategies, as proposed in the sixth chapter of this thesis. These forward-thinking approaches can serve as a catalyst toward designing spaces that actively mitigate human-wildlife conflicts in United States National Parks. By nudging visitors towards positive wildlife viewing behaviors and compliance with park regulations, we can protect the unique natural and cultural treasures held within our national parks for generations to come.

BIBLIOGRAPHY

Abrams, K. M., Leong, K., Melena, S., & Teel, T. (2020). Encouraging Safe Wildlife Viewing in National Parks: Effects of a Communication Campaign on Visitors' Behavior. *Environmental Communication, 14*(2), 255–270. https://doi.org/10.1080/17524032.2019.1649291

Agrawal, A., & Gibson, C. C. (1999). Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation. *World Development, 27*(4), 629–649. https://doi.org/10.1016/S0305-750X(98)00161-2

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I., & Fishbein, M. (2000). Attitudes and the Attitude-Behavior Relation: Reasoned and Automatic Processes. *European Review of Social Psychology, 11*(1), 1–33. https://doi.org/10.1080/14792779943000116

Anderson, D. H., Lime, D. W., & Wang, T. L. (1998). Maintaining the quality of park resources and visitor experiences: A handbook for managers. University of Minnesota, Department of Forest Resources, Cooperative Park Studies Unit. https://pubs.usgs.gov/publication/93796

Anderson, L. E., Manning, R. E., Valliere, W. A., & Hallo, J. C. (2010). Normative Standards for Wildlife Viewing in Parks and Protected Areas. *Human Dimensions of Wildlife, 15*(1), 1–15. https://doi.org/10.1080/10871200903360098

Arno, A., & Thomas, S. (2016). The efficacy of nudge theory strategies in influencing adult dietary behaviour: A systematic review and meta-analysis. *BMC Public Health, 16*(1), 676. https://doi.org/10.1186/s12889-016-3272-x

Booth, N. K. (1989). Basic elements of landscape architectural design. Waveland press.

Bourassa, S. C. (1990). A Paradigm for Landscape Aesthetics. *Environment and Behavior, 22*(6), 787–812. https://doi.org/10.1177/0013916590226004

Fogg, B. (2009). A behavior model for persuasive design. In *Proceedings of the 4th International Conference on Persuasive Technology* (pp. 1–7). https://doi.org/10.1145/1541948.1541999

Freeman, S. (2022). The efficacy of persuasive communication strategies for reducing human-wildlife conflicts in parks and protected areas. Unpublished.

Freeman, S., Taff, B. D., Lawhon, B., Benfield, J. A., Kreye, M., Newton, J., Miller, L., & Newman, P. (2023). The impact of message framing on wildlife approach during ungulate viewing experiences in the Greater Yellowstone Ecosystem. *Journal of Interpretation Research, 28*(1), 7–24. https://doi.org/10.1177/10925872231157596

Freeman, S., Taff, B. D., Miller, Z. D., Benfield, J. A., & Newman, P. (2021). Mutualism wildlife value orientations predict support for messages about distance-related wildlife conflict. *Environmental Management, 67*(5), 920–929. https://doi.org/10.1007/s00267-020-01414-1

Godin, G., Conner, M., & Sheeran, P. (2005). Bridging the intention–behavior gap: The role of moral norm. *British Journal of Social Psychology, 44*(4), 497–512. https://doi.org/10.1348/014466604X17452

Graham, G. (2005). *Philosophy of the Arts: An Introduction to Aesthetics*. Routledge.

Greider, T., & Garkovich, L. (1994). Landscapes: The social construction of nature and the environment. *Rural Sociology, 59*(1), 1. [Database Name or URL]

Hammitt, W. E., Dulin, J. N., & Wells, G. R. (1993). Determinants of quality wildlife viewing in Great Smoky Mountains National Park. *Wildlife Society Bulletin, 21*(1), 21–30.

Hassan, L. M., Shiu, E., & Shaw, D. (2016). Who says there is an intention–behavior gap? Assessing the empirical evidence of an intention–behavior gap in ethical consumption. *Journal of Business Ethics, 136*(2), 219–236. https://doi.org/10.1007/s10551-014-2440-0

Hefferan, E. (2022, May 6). Yellowstone's Wildlife Central. *Yellowstone National Park*. https://www.yellowstonepark.com/things-to-do/wildlife/lamar-hayden-valley/

Jackson, J. B. (1994). *A Sense of Place, a Sense of Time*. Yale University Press.

Kaltenborn, B. P., & Bjerke, T. (2002). Associations between environmental value orientations and landscape preferences. *Landscape and Urban Planning, 59*(1), 1–11. https://doi.org/10.1016/S0169-2046(01)00243-2

Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and Emotion, 17*(2), 297–314. https://doi.org/10.1080/02699930302297

Kryder-Reid, E. (1994). The archaeology of vision in eighteenth-century Chesapeake gardens. *The Journal of Garden History, 14*(1), 42–54. https://doi.org/10.1080/01445170.1994.10412496

Kyle, G., Graefe, A., Manning, R., & Bacon, J. (2004). Effects of place attachment on users' perceptions of social and environmental conditions in a natural setting. *Journal of Environmental Psychology, 24*(2), 213–225. https://doi.org/10.1016/j.jenvp.2003.12.006

Lawhon, B., Newman, P., Taff, D., Vaske, J., Vagias, W., Lawson, S., & Monz, C. (2013). Factors influencing behavioral intentions for Leave No Trace behavior in national parks. *Journal of Interpretation Research, 18*(1), 23–38. https://doi.org/10.1177/109258721301800103

Lebrun, A.-M., Su, C.-J., & Bouchet, P. (2021). Domestic tourists' experience in protected natural parks: A new trend in pandemic crisis? *Journal of Outdoor Recreation and Tourism, 35*, 100398. https://doi.org/10.1016/j.jort.2021.100398

Lee, R. M. (2019). Unobtrusive Methods. In P. Liamputtong (Ed.), *Handbook of Research Methods in Health Social Sciences* (pp. 491–507). Springer Singapore.

Lemelin, R. H., & Smale, B. (2006). Effect of environmental context on the experience of polar bear viewers in Churchill, Manitoba. *Journal of Ecotourism, 5*(3), 176–191. https://doi.org/10.2167/joe142.0

Mainzer, S., & Luloff, A. E. (2017). Informing environmental problems through field analysis: Toward a community landscape theory of pro-environmental behavior. *Community Development*, *48*(4), 483-498. https://doi.org/10.1080/15575330.2017.1325918

Manning, R. E., & Freimund, W. A. (2004). Use of Visual Research Methods to Measure Standards of Quality for Parks and Outdoor Recreation. *Journal of Leisure Research, 36*(4), 557–579. https://doi.org/10.1080/00222216.2004.11950036

Mateer, T. J., Taff, B. D., Miller, Z. D., & Lawhon, B. (2020). Using visitor observations to predict proper waste disposal: A case study from three US national parks. *Current Research in Environmental Sustainability, 1*, 16–22. https://doi.org/10.1016/j.crsust.2020.01.001

McClelland, L. F. (1998). *Building the National Parks: Historic Landscape Design and Construction*. JHU Press.

Miller, Z. D., & Freimund, W. (2018). Using visual-based social norm methods to understand distance-related human–wildlife interactions. *Human Dimensions of Wildlife, 23*(2), 176–186. https://doi.org/10.1080/10871209.2017.1397825

Moore, R. L., & Graefe, A. R. (1994). Attachments to recreation settings: The case of rail-trail users. *Leisure Sciences, 16*(1), 17–31. https://doi.org/10.1080/01490409409513214

Moore, R. L., Leung, Y.-F., Matisoff, C., Dorwart, C., & Parker, A. (2012). Understanding users' perceptions of trail resource impacts and how they affect experiences: An integrated approach. *Landscape and Urban Planning, 107*(4), 343–350. https://doi.org/10.1016/j.landurbplan.2012.06.016

Myers, M. E. (2004). The Line of Grace: Principles of Road Aesthetics in the Design of the Blue Ridge Parkway. *Landscape Journal, 23*(2), 121–140. https://doi.org/10.3368/lj.23.2.121

Myers, M. E. (2006). Power of the Picturesque: Motorists' Perceptions of the Blue Ridge Parkway. *Landscape Journal, 25*(1), 38–53. https://doi.org/10.3368/lj.25.1.38

Nassauer, J. I. (1995). Messy Ecosystems, Orderly Frames. *Landscape Journal, 14*(2), 161–170. https://doi.org/10.3368/lj.14.2.161

National Park Service. (2023a). *Greater Yellowstone Ecosystem—Yellowstone National Park*. https://www.nps.gov/yell/learn/nature/greater-yellowstone-ecosystem.htm

National Park Service. (2023b). *Laws, Policies & Regulations*. https://www.nps.gov/aboutus/lawsandpolicies.htm

National Park Service. (2023c). *Wildlife–Human Conflicts in Yellowstone—Greater Yellowstone*. https://www.yumpu.com/en/document/view/22072978/wildlife-human-conflicts-in-yellowstone-greater-yellowstone-

National Park Service. (2023d). *Visitor Statistics Report—YELL*. https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20(1904%20-%20Last%20Calendar%20Year)?Park=YELL

National Park Service, & US, W. 82190-0168 P. 307-344-7381 C. (2020). Woman gored after approaching bison in Yellowstone National Park; Always stay more than 25 yards away from bison—Yellowstone National Park. https://www.nps.gov/yell/learn/news/062920.htm

Parrott, L., & Meyer, W. S. (2012). Future landscapes: Managing within complexity. *Frontiers in Ecology and the Environment*, 10(7), 382–389. https://doi.org/10.1890/110082

Pedwell, C. (2017). Habit and the Politics of Social Change: A Comparison of Nudge Theory and Pragmatist Philosophy. *Body & Society*, 23(4), 59–94. https://doi.org/10.1177/1357034X17734619

Schänzel, H., & McIntosh, A. (2010). An Insight into the Personal and Emotive Context of Wildlife Viewing at the Penguin Place, Otago Peninsula, New Zealand. *Journal of Sustainable Tourism*, February 1, 36–52. https://doi.org/10.1080/09669580008667348

Shaw, P. (2017). *The Sublime*. Taylor & Francis.

Simpson, J., & Belsky, J. (2008). Attachment theory within a modern evolutionary framework (pp. 131–157).

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behavior: An integrative review and research agenda. *Journal of Environmental Psychology*, 29(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.

Tuan, Y. F. (1979). Space and place: humanistic perspective. In *Philosophy in geography* (pp. 387-427). Dordrecht: Springer Netherlands.

Ward, C. W., & Roggenbuck, J. (2003). Understanding Park Visitors' Response to Interventions to Reduce Petrified Wood Theft. *Journal of Interpretation Research*, 8(1), 67–82. https://doi.org/10.1177/109258720300800106

Whyte, W. F. (1984). *Learning from the Field: A Guide from Experience*. SAGE.

XiaoXiao, Q., Liang, Z., & YingChun, H. (2018). Tourists' awe and environmentally responsible behavior: The mediating role of place attachment. *Tourism Tribune*, 33(11), 110–121.

Zhang, Q., & Xu, H. (2020). Understanding aesthetic experiences in nature-based tourism: The important role of tourists' literary associations. *Journal of Destination Marketing & Management*, 16, 100429. https://doi.org/10.1016/j.jdmm.2020.100429

Appendix A

Observation Instrument

Viewing behavior

	Counts
Smartphone camera	
Tablet device	
Point and shoot camera	
D-SLR camera	
Spotting scope	
Binoculars	
Other:	

Visitor behavior

	Count
People in designated pullout	
People in non-designated pullout	
People on road	
People on social trail	
People on designated trail	
People off trail (e.g., on vegetation)	
People on structures	
Wildlife feeding	

Wildlife presence

	Yes	No
Bison	○	○
Big horn sheep	○	○
Bird: ____	○	○
Black bear	○	○
Coyote	○	○
Deer ____	○	○
Elk	○	○
Fox	○	○
Grizzly	○	○
Moose	○	○
Pronghorn	○	○
Wolves	○	○
Other: ____	○	○

Species

Counts						Distance in Yards	
Number per species	Number of people approaching wildlife	Number of people crossing road	Number of people crossing boulders	Number of people crossing fencing	Number of people crossing log	Wildlife distance to pullout	Closest approaching human distance to pullout

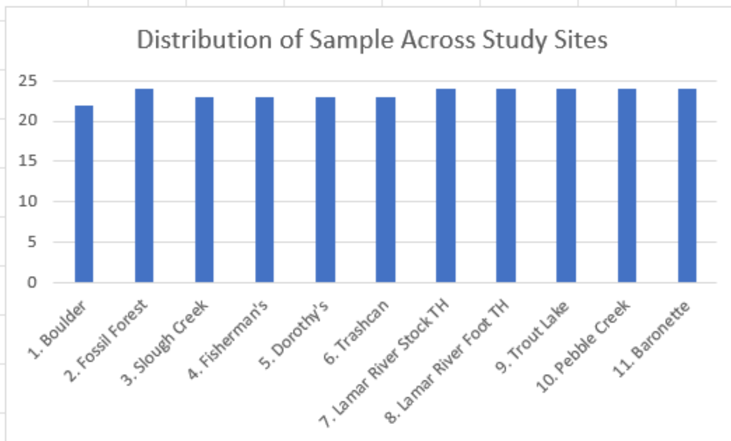
Data collection site

- ○ 1. Boulder
- ○ 2. Fossil Forest
- ○ 3. Slough Creek
- ○ 4. Fisherman's
- ○ 5. Dorothy's
- ○ 6. Trashcan
- ○ 7. Lamar River Stock TH
- ○ 8. Lamar River Foot TH
- ○ 9. Trout Lake
- ○ 10. Pebble Creek
- ○ 11. Baronette

Appendix B

Data Distribution

1. Boulder	22
2. Fossil Forest	24
3. Slough Creek	23
4. Fisherman's	23
5. Dorothy's	23
6. Trashcan	23
7. Lamar River Stock TH	24
8. Lamar River Foot TH	24
9. Trout Lake	24
10. Pebble Creek	24
11. Baronette	24
Total Observations	258



Appendix C

Descriptive Analyses: Infrastructure and Use Inventory

	Infrastructure Variables	Boulder	Fossil Forest	Slough Creek	Fisherman's	Dorothy's	Trashcan	Lamar River Stock TH	Lamar River Foot TH	Trout Lake	Pebble Creek	Baronette
	Study Sites											
	Barrier type											
A1	both fence and log				■				■			
A2	fence					■						
A3	rock	■		■			■					■
A4	log		■					■		■	■	
	Surface type											
B1	paved						■	■	■	■	■	
B2	both	■	■		■	■						■
B3	gravel			■								
	Trail Type											
C1	designated											
C2	both designated and social							■	■	■	■	
C3	no trail			■			■					■
	Signage Type											
D1	sign combination				■			■	■	■	■	
D2	behavioral management			■								
D3	interpretative		■									
D4	no signage	■				■	■					■

	Use-Indicator Variables	Boulder	Fossil Forest	Slough Creek	Fisherman's	Dorothy's	Trashcan	Lamar River Stock TH	Lamar River Foot TH	Trout Lake	Pebble Creek	Baronette
	Social Trails											
E1	sites that have social trails	■	■		■	■						■
	Edge Effects											
F1	0-12"	■		■								■
F2	12-24'					■	■					
F3	>24"		■		■			■	■	■	■	

EXISTING INFRASTRUCTURE AND USE TYPES AND CATEGORIES

INFRASTRUCTURE

USE INDICATORS

Social Trails

Edge Effect

CURRICULUM VITAE

OLIVIA KRUM
Undergraduate Student Of Landscape Architecture
Stuckeman School of Architecture and Landscape Architecture
The Pennsylvania State University

ogk5015@psu.edu | 814.321.8827

EDUCATION

THE PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK
B.L.A, Stuckeman School of Architecture & Landscape Architecture, 2019-Present
Emphasis on Recreation, Parks, and Tourism Management, 2019-Present

C. BARTON MCCANN SCHOOL OF ART, PETERSBURG, PA
Fine Art and Ceramic studies, 2015-2017

PENNS VALLEY JUNIOR SENIOR HIGH SCHOOL, SPRING MILLS, PA
High School Diploma, 2015-2019

RECOGNITION AND GRANTS

NATIONAL

NATIONAL UDALL SCHOLAR, 2022
Udall Foundation, Executive Branch Agency
Leadership and Commitment in Working With Indigenous Nations and The Environment

WESTERN RESERVE HERB SOCIETY SCHOLAR, 2022
Horticultural Society, OH
Dedication to Environmental Stewardship

UNIVERSITY

SCHREYER HONORS AND ACADEMIC EXCELLENCE, 2019-2023
Schreyer Honors College Scholarship, The Pennsylvania State University
Commitment to Global and Ethical Perspective and Civic Engagement

ARTHUR MITCHELL HONORS, 2022
University Scholarship, The Pennsylvania State University
Recognizing Future American Leaders and Commitment To Public Service

SEMMER GRANT, 2022
The Pennsylvania State University
Broadening Perspectives Through Global Education

MCCALIPS AND V HONORS GRANT, 2021
The Pennsylvania State University
Dedication to International Relations and Experiences

COLLEGE OF ARTS AND ARCHITECTURE

BROCK HONORS RECOGNITION, 2022
College-Level Scholarship, The Pennsylvania State University
Recognizing Ability To Make Differences in The World

DEPARTMENT OF LANDSCAPE ARCHITECTURE

KAUFFMAN FAMILY SCHOLAR, 2022

ERNEST GRAHAM SCHOLAR, 2022

DEPARTMENT EXCELLENCE AWARD, 2020-2022

SERVICE AND LEADERSHIP AWARD, 2021

ACADEMIC EXPERIENCE

RESEARCH

PROTECTED AREAS RESEARCH COLLABORATIVE, 2021-2023

Field Technician, Wildlife and Human Conflict, Greater Yellowstone and Grand Teton
Field Lead, Wolf Population and Habituation, Greater Yellowstone and Grand Teton
Field Lead, Protected Areas Light Pollution Pilot Study, University Park
Field Lead, Protected Areas Light Pollution Study, Grand Teton National Park
Field Lead, Bear and Safety Communication Study, Bridger-Teton National Forest
Project Lead, Persuasive Design and Visitor Managment, Yellowstone National Park

ECOLOGY + DESIGN RESEARCH COLLABORATIVE, 2022

Research Assistant, Placemaking and Politics Metareview, University Park

ASSISTANTSHIPS

DEPARTMENT OF LANDSCAPE ARCHITECTURE, 2019-2023

Teaching Assistant, Human Dimensions in The Landscape, 2023
Teaching Assistant, Undergraduate Studio First-Year Level, 2021
Teaching Assistant, Landscape Architecture Late Acceptance Program, 2019-2021

SPECIALTY COURSES

RECREATION PARKS AND TOURISM MANAGEMENT

Inclusive Leisure Services Seminar | Scenario-Workshops
Health and Human Relations With the Landscape Seminar | Public Speaking

PROFESSIONAL EXPERIENCE

STAHL SHEAFFER CIVIL ENGINEERING, STATE COLLEGE PA

Intern, Roadway Design and Marketing, 2018-2020
Operated Geotechnical equipment and CAD software, published project write-ups

EXTRACURRICULR ACTIVITIES

UNIVERSITY

Public Relations officer, Arts and Architecture Student Council, 2020-2022
Landscape Architecture Student Society, General Member, 2019-2023
American Society of Landscape Architects, Student Member, 2020-2023
Arts and Architecture Student Ambassador, 2019-2023

ENVIRONMENTAL

Penn State Chesapeake Bay Club, 2020-2022
Chesapeake Bay Student Leadership Council, 2017-2019
Penn State Outing Club, 2020-2022
Penns Valley Outdoors Club, Founder, 2019

ATHLETIC

Vole Dance Team, Penn State, 2019-2022