
Visitor Use and Associated Thresholds at Buffalo National River

2016-2017

Research Report

Final Project Report Prepared by (listed alphabetically):

Project Directors and Principle Investigators

Matthew T.J. Brownlee, Ph.D.¹
Ryan Sharp, Ph.D.²

Project Coordinators

Tyler Cribbs²
Brian Peterson, M.S.¹

¹ Park Solutions Lab
Department of Parks, Recreation, and Tourism Management
Clemson University
Clemson, South Carolina

² Park Management and Conservation Lab
Department of Horticulture and Natural Resources
Kansas State University
Manhattan, Kansas

Substantial assistance in data processing and data organization provided by Brittany Lacy and Kaitlyn Mitchell in the Park Solutions Lab at Clemson University. Additional assistance was provided by Justin Jones, Tommy Giordano, Karl Noren and Susi Algrim in the Park Management and Conservation Lab at Kansas State University.



EXECUTIVE SUMMARY

Project Overview

The purpose of this research was to gather baseline information to help support visitor use management and planning at Buffalo National River (BUFF). The results can be used to support visitor use management (VUM) and planning at BUFF. Specifically, this research summary is intended to inform and guide NPS managers in providing sustainable and appropriate visitor experiences and visitor uses in the park. The objectives of this study included: 1) evaluate the frequency, type, and temporal and spatial distributions of visitor use at BUFF within and across seasons; 2) determine the relationships between use patterns and socioecological conditions in key unit locations, 3) application of research surveys that captured visitors' desired conditions, 4) survey trails and conditions in the Lower Buffalo Wilderness Area, and 5) design a sampling and monitoring protocol framework for future implementation which will evaluate efficacy of management actions and general changes in use, desired conditions, and actual conditions.

Using a normative approach, reliant on indicators and thresholds, this research summary describes information about conditions in the Lost Valley and Eden Falls area, Ponca Access area, Hemmed in Hollow, Kyle's Landing, Hasty Access, Gilbert Landing, Indian Rockhouse, Dillard's Ferry, Hathaway Trailheads, and the Lower Buffalo Wilderness. The researchers employed the use of quantitative questionnaires, visual methods, Human Behavior Cameras (HBCs), Parking Lot Cameras (PLCs), infrared trail counters, field-based GPS technology and Geographic Information Systems (GIS) for mapping purposes.

Researchers distributed three quantitative visitor questionnaires at the Eden Falls trailhead, Kyle's Landing, and Dillard's Ferry. The first questionnaire evaluated visitors' preferences for crowding conditions along BUFF. The second questionnaire investigated visitors' preferences for crowding conditions at Eden Falls and on hiking trails. The third questionnaire examined visitor support (or opposition) for current and potential management strategies in the Lost Valley and Eden Falls area.

Although the questionnaires were critical to capture visitor preferences for conditions, researchers assessed objective visitor use levels by deploying high-resolution infrared cameras and infrared trail counters. Researchers used data from these instruments to compare the alignment (or lack thereof) between visitors' preferences from the questionnaires and observed conditions in specific areas. The researchers stationed Human Behavior Cameras (referred to here forward as HBCs) at the following locations: Eden Falls, Ponca Access, Kyle's Landing, Hasty Access, and Dillard's Ferry. The HBCs recorded the use conditions (e.g., number of visitors, boats, vehicles) during daylight hours. Researchers deployed Parking Lot Cameras (PLCs) at Compton Trailhead and two locations at Hathaway near the Lower Buffalo Wilderness to assess the number of vehicles during daylight hours. Researchers deployed trail counters at Hemmed in Hollow, Gilbert, and Indian Rockhouse. The data from the trail counters enabled the researchers to determine temporal visitor-use patterns.

Researchers mapped and evaluated the trails and trailheads in the Lower Buffalo Wilderness Area, including the trail locations where ecological trail impacts were prominent. An interactive

KMZ file operable in Google Earth displays these findings and is included as part of this research report.

The report is organized in the following sections: 1) Introduction, Objectives, Methods; 2) Research findings for Lost Valley; 3) Results related to Boats at One Time on the river (BAOT); 4) Results related to river encounters with other groups per hour; 5) Results related to People at One Time (PAOT) at river access points; 6) Results related to Vehicles at One Time (VAOT); 7) Temporal distributions of use at trail counter locations 8) Lower Buffalo Wilderness Area trail locations and conditions; and 9) Flood photographs.

Key Recommendations

General

- Consider integrating the results and outcomes of this project into park plans, planning, and management efforts. This may include considering formal thresholds for the indicator variables investigated in this report. Results presented in this report offer a range of potential thresholds and triggers that might be used for each indicator. Also, consider designating responsibilities and schedules for future monitoring of indicators.
- Continue to develop detailed management alternatives to enact in case monitoring indicates that thresholds are violated or triggers are activated. Consider pilot testing potential management alternatives prior to their full implementation to gauge their effectiveness. This might include outside review/assistance by subject matter experts or developing a computer model to simulate and test the outcomes of potential management alternatives.

Boxley/Lost Valley and Eden Falls

- Based on visitors' desires, consider a) creating a new campground in the Boxley/Lost Valley area, and/or b) establishing a visitor center in the Boxley/Lost Valley area. However, these recommendations are only based on visitors' desires and should be balanced with other management considerations, which, at times, may take precedent.
- When planning for management strategies and potential development in the area, consider visitor preferred conditions for crowding in the area: a) no more than 38 people are at Eden Falls at one time, and b) no more than 35 other people are encountered during one-hour while hiking.
- The number of vehicles at one time at the Eden Falls trailhead parking lot cannot be used to accurately predict the number of people at one time at Eden Falls and associated thresholds at Eden Falls. As a result, although the Eden Falls parking lot should likely be managed with Eden Falls conditions in mind, the number of vehicles at the parking lot should not be considered the primary element for managing the number of people at one time at the falls.

River and River Access Areas

- When planning for management strategies and potential development in the area, consider visitor preferred conditions for crowding in the area. However, these recommendations are only based on visitors' desires and should be balanced with other management considerations, which, at times, may take precedent.

- No more than 22 people with watercraft at one time at smaller river access sites, such as Ponca, Hasty, and Kyle's Landing
- No more than 50 people with watercraft at one time at larger river access sites, such as Dillard's Landing and Gilbert
- No more than 37 other people encountered during one-hour while on the river
- No more than 13 other boats within view at one time on the river

Lower Buffalo Wilderness

- Consider resolving the five trail impact areas identified in this report.
- Maintain current management strategies and practices in the Lower Buffalo Wilderness Area.

Monitoring Visitor Use

- As resources allow, consider following the monitoring of indicators described in this report. This would help ensure that visitation changes resulting from management action are deliberately and appropriately evaluated for their efficacy.
- As resources allow, consider following the monitoring protocol (Appendix D) prior to and after management action to determine the efficacy of action on use levels and perceived crowding.
- As needed, consider continuing to partner with university faculty and graduate students to help implement the monitoring protocols outline in Appendix D.

Key Findings

OVERALL RESULTS FOR LOCATIONS OTHER THAN EDEN FALLS/LOST VALLEY

Demographics

- On average, respondents were 48 years of age with gender evenly split between males and females.
- 23% of visitors reported receiving a graduate/professional degree, 18% received some college, and 32% received a four-year degree.
- Most respondents (87%) self-identified as white, and 5% self-identified as Hispanic or Latino/Latina.
- Respondents had varying levels of total household income.
- 39.1% of visitors to BUFF reported residing in Northwest Arkansas. Outside of Arkansas, the city that had the highest percentage of visitors was Kansas City (8.6%).
- The average visitor group had six people.

Perceived crowding

- **Generally, visitors reported not feeling crowded during their experience at BUFF.** This finding suggests that visitors may not feel that current conditions experienced during their visit facilitated feelings related to crowding.
- **Overall, general results indicate that on average use levels and crowding conditions (number of people, boats, encounters with others) are within an acceptable range based on visitor preferences.** However, there are periods when use levels and exceed visitors' desired conditions.
- **In general, visitors recreating in the upper and lower river express consistent desired and acceptable conditions for use levels and associated crowding.**

Other boats within view at one time on the river: Desired and actual conditions

- **Although visitor reported conditions for other boats in view are within the acceptable range, they are moderately acceptable to visitors.**
- Visitors indicated that as the number of other boats within view at one time on the river increases that the quality of their experience decreases. Specifically, acceptability of conditions decreases by approximately 11% for every increase of 6 boats within view at one time on the river.
- Visitors report that 13 or more boats within view at one time on the river is unacceptable.
- 71% of visitors report that the NPS should take management action when 14 boats are within view at one time on the river.
- 65% of visitors report they would not return to BUFF when there are, on average, 16 boats within view at one time on the river.
- 16% of visitors reported that use on the river should never be limited regardless of boating levels, suggesting that a portion of the visiting population is ideologically opposed to use limits.
- Visitors report that *average* weekday (9 boats within view at one time) and weekend/holiday (10 boats within view at one time) are within the acceptable range (0 to

13 boats within view at one time). These average conditions for boats within view at one time on the river do not exceed or violate visitors' threshold (13 boats) but these are not ideal conditions according to visitors.

- **There are periods when the weekday conditions for boats within view at one time on the river as reported by visitors far exceeds visitors' desired conditions.**

Number of encounters with people during a one-hour period on the river: Desired and actual conditions

- Results indicate that when visitors encounter more people while recreating on the river, the quality of their experience decreases. Specifically, acceptability of conditions decreases by approximately 10% for every 20 additional people encountered per hour on the river.
- On average, visitors report that when there are more than 37 people encountered per hour then conditions become unacceptable.
- Visitors report that management action is required when 70 people are encountered per hour on the river.
- Visitors report that they would no longer visit the river after encountering 81 people per hour on the river.
- Visitor reported conditions indicate that *average* weekday (21 people encountered on upper river; 16 encountered on lower river) and weekend/holiday (35 people encountered on upper river; 25 encountered on lower river) conditions are within the acceptable range (0 to 39 people encountered per hour).
- **The average encounter conditions on the river do not exceed or violate visitors' threshold (39 people encountered per hour) but are not ideal conditions according to visitors.**
- **There are periods when the weekday conditions for encounters reported in the upper river (60 people encountered per hour) exceeds visitors' desired conditions.**
- Weekday encounters in the lower river (20 people) appear to be below visitor thresholds.

People at one time at river access areas: Desired and actual conditions

- Desired and actual conditions for People at One Time at River Access Areas were evaluated at Ponca Access, Kyle's Landing, Hasty Access, and Dillard's Ferry.
- The results display decreasing levels of acceptability as the number of people at river access areas increase. Specifically, acceptability of conditions decreases by approximately 10% for every increase of a) 8 people at Ponca, Kyle's, and Hasty (or similar access areas); and b) 20 people at Dillard's.
- **Visitors report that 50 people or more at one time at Dillard's (or similar access areas) is unacceptable and that approximately 22 people or more at one time at Ponca, Kyles, and Hasty (or similar areas) is unacceptable (i.e., the threshold).**
- At Dillard's (or similar areas), 86% of visitors report that the NPS should take management action when 49 people are present at one time and 78% report that they would not return to the site if 54 people were present at one time.
- At Ponca and Kyles (or similar areas), approximately 80% of visitors report that the NPS should take management action when 20 people are present at one time and 75% report that they would not return to the site if 22 people were present at one time.

- **Approximately 16% of visitors reported that use at river access areas should never be limited regardless of conditions, suggesting that a portion of the visiting population is ideologically opposed to use limits.**
- At Dillard's, the average weekday (1 person), weekend (5 people), and holiday (5 people) conditions are within the acceptable range (0 to 50 people at one time). Alternatively stated, the average conditions at Dillard's Ferry do not exceed or violate visitors' threshold for the amount of people at one time.
- At Ponca, Kyles, and Hasty, the *average* weekday (1-2 people), weekend (2-3 people), and holiday (1-4 people) conditions are within the acceptable range (0 to 22 people). Alternatively stated, the average conditions at Ponca, Kyles, and Hasty do not exceed or violate visitors' threshold for the amount of people at one time.
- However, **there are several times in the year when the *maximum* count on a weekday, holiday, or weekend recorded by the camera exceeded visitors' desired conditions. Specifically, on separate days there were 74 people at one time at Hasty, 70 at Ponca, and 28 at Kyles.** These conditions far exceed the threshold of 22 people at one time for these sites.

Parking lot use at the Compton Trailhead

- **Compton Trailhead parking lot to access Ponca Wilderness receives relatively consistent use, especially during the middle of the day.**
- Spring is the busiest season at the Compton Trailhead, with an hourly average of 4.64 vehicles.
- There is also use in the Fall season at the Compton Trailhead, with an hourly average of 4.50 vehicles.

Visitor use and activity at Hathaway Trailheads

- Hathaway Trailheads into the Lower Buffalo Wilderness Area do not experience frequent use, which is a finding experienced by researchers onsite during attempts to distribute questionnaires at this location.
- **Data suggests that the Lower Buffalo Wilderness receives limited use via access from Hathaway trailhead.**
- One day during October resulted in reaching parking lot capacity.

Ecological trail conditions in the Lower Buffalo Wilderness Area

- The researchers found trail impacts to be prominent in five locations in the Lower Buffalo Wilderness, a relatively low number compared to other high use areas in other NPS units.
- **The trail system of the Lower Buffalo Wilderness receives low use, and consequently has experienced limited ecological impact to the trails. Except for the five trail impact locations discovered by the researchers, the rest of the trails were not ecologically impacted.**
- Litter was prominent at one location (36.16154, -92.42610).
- According to survey results, average visitors have difficulty determining desired trail conditions or acceptable levels of recreation-related impact on trails.

LOST VALLEY AND EDEN FALLS AREA

Demographics

- On average, respondents were 38 years of age with gender evenly split between males and females.
- 19% of visitors reported receiving a graduate/professional degree, 22% received some college, and 30% received a four-year degree.
- Most respondents (83%) self-identified as white, and 7% self-identified as Hispanic or Latino/Latina.
- Respondents had varying levels of total household income.
- Most respondents were from Northwest Arkansas.

Past use or past visitor history at the park

- 27% of visitors to the Eden Falls area reported being first time visitors.
- 60% of visitors reported relatively low annual visitation (four days per year) and limited visitation history (four years since their first visit, on average).
- 12% of the visitors reported relatively low annual visitation (five days annually, on average) but a long visitation history (29 years since their first visit).
- The smallest visitor group (1% of visitors) reported high annual visitation (63 days annually, on average) and a long visitation history (20 years since their first visit, on average).
- The average visitor group had four people traveling together with 32% of visitors traveling in groups of two.

Activities

- 81% of visitors reported that “hiking” was their main reason for visiting the area followed by experiencing “Nature/Wildlife”, which was reported by 33% of visitors.

Satisfaction with facilities and information

- **Most visitors were either “somewhat satisfied” or “satisfied” with the current conditions of facilities at BUFF, including but not limited to trails, restroom, signs, general park information, and picnic areas.**
- Very few visitors reported dissatisfaction with facilities; however, 26% of visitors reported some level of dissatisfaction with the *amount* of information available about the park.
- 26% of visitors reported some level of dissatisfaction with the *quality* of information available about the park.

Desire for management action in the Lost Valley/Boxley Valley area

- **Visitors to BUFF generally support the expansion or creation of new facilities in Lost Valley/Boxley Valley area.** Overall, four of the six proposed management actions drew support from BUFF visitors.
- **The Management Action Index indicates that creating a new campground in the area and establishing a visitor center are the two most preferred actions by visitors.**
- When visitors were faced with only being able to choose one potential management action, over one third of visitors (35%) chose to create a new campground followed by

the establishment of a visitor center (26%) and expanding restroom facilities (16%). When faced with the option of not selecting a potential management action, only 5% of visitors chose to not select an item from the list.

- The creation of a new campground had the most support by visitors with 43.8% of visitors “supporting” of “strongly supporting” this management action.
- The establishment of additional parking and the creation of new pullouts for elk viewing received less support than other management actions.

Desired and actual conditions at Eden Falls

- Visitors indicated that as the number of people at Eden Falls increases that the quality of their experience decreases.
- **Visitors report that 38 people or more present at one time at Eden Falls is unacceptable.**
- 71% of visitors report that the NPS should take management action when 52 people are present at one time at Eden Falls.
- 64% of visitors report they would not return to the site when there are 60 people or more present at Eden Falls at one time.
- Cameras placed at Eden Falls indicate that on average there is one person at Eden Falls per hour during a typical weekday. Cameras also indicate that during weekends and holidays that there are two people present at Eden Falls per hour, on average. According to visitors, this average level of visitor use for weekdays, weekends, and holidays is acceptable.
- Between 7:00 am and 7:00 pm, visitors are present at Eden Falls for 31% of the time on weekdays, 54% of the time on weekends, and 58% of the time on holidays.
- **There were a couple times in the year when the number of people present at one time at Eden Falls was only marginally acceptable to visitors.**
- **The number of vehicles at one time at the Eden Falls trailhead parking lot cannot be used to accurately predict the number of people at one time at Eden Falls and associated thresholds at Eden Falls.** As a result, although the Eden Falls parking lot should likely be managed with Eden Falls conditions in mind, the number of vehicles at the parking lot should not be considered the primary element for managing the number of people at one time at the falls.

Desired and actual amount of hiking encounters per hour

- When visitors encounter more people while hiking on a trail the quality of their experience decreases.
- **Visitors report that when they encounter 35 or more hikers during one hour of hiking then visitor use levels become unacceptable.**
- Visitors report that the NPS should take management action when 40 people or more are encountered per hour while hiking.
- Visitors report that they would not return to BUFF if they encountered 44 people per hour while hiking.
- Visitors report encountering 11 people during one hour of hiking on weekdays, 14 people during one hour of hiking on weekends, and 25 people during one hour of hiking on holidays. All of these visitor use levels are reported as ‘acceptable’ to visitors recreating in the Eden Falls area.

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- There are periods during the year when the number of other visitors encountered during one-hour of hiking did not align with visitors' desired conditions. Specifically, 1.5% of visitors sampled on weekdays reported encountering 50 or more people during one hour of hiking and 5% of visitors sampled on weekends reported encountering 50 or more people during one hour of hiking. **25% visitors intercepted on holidays reported encountering 50 or more people during one hour of hiking. Visitors reported that encountering 50 or more people during one hour of hiking is unacceptable, requires management action, and may influence their desire to revisit the area.**
 - On holiday and weekends, approximately 30% of visitors are reporting that the number of people that they encounter during one hour of hiking 'requires management action' by the NPS.

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Introduction and Rationale

The National Park Service's (NPS) enabling legislation (the Organic Act of 1916) mandates park managers to protect and maintain the natural and scientific values of the park and to provide for public enjoyment, education, and inspiration (NPS, 2016). This protection-visitor use dual mandate is applicable to all NPS units, including BUFF (Figure 1, Figure 2). BUFF features natural, cultural, and recreational resources that invite a diverse population of visitors.

Established in 1972 as America's first national river, BUFF protects 135 river miles from industrial uses, impoundments, and other obstructions that may alter the river flow and disrupt the natural habitat of flora and fauna. It is one of few free-flowing rivers in the contiguous United States. In 2016, nearly 1.8 million visitors came to BUFF (NPS, 2017).

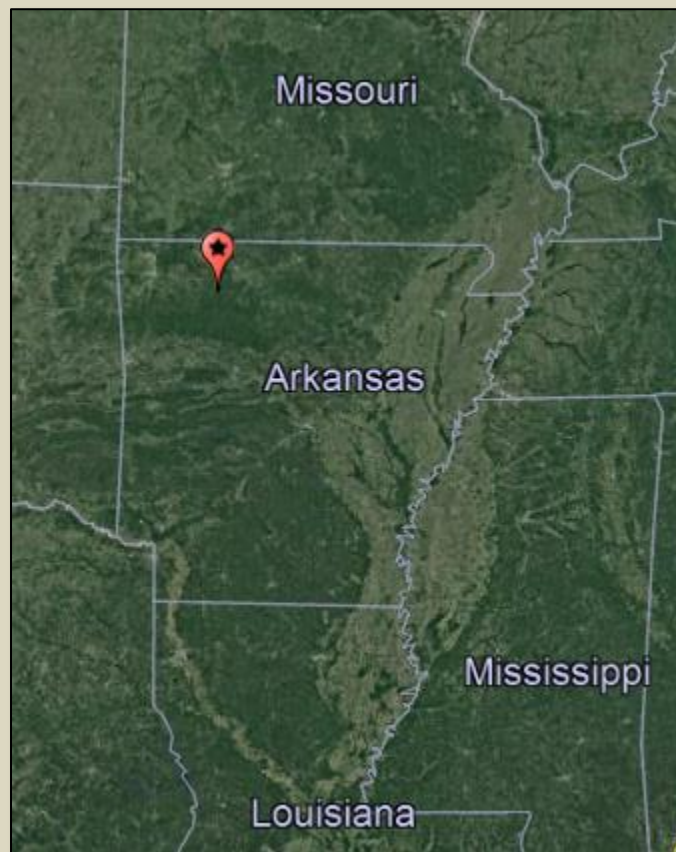


Figure 1. Approximate location of BUFF in northwest Arkansas.

Not surprisingly, the high intensity of visitation in the park has posed some of the most significant management concerns. High visitor use challenges park managers to develop effective and efficient management strategies for addressing important visitor use and impact issues. One of such issues is that of visitor carrying capacity or user capacity, which is often referred to as the appropriate type and amount of visitor use the park area can accommodate without unacceptably degrading either park resources or the visitor experience.

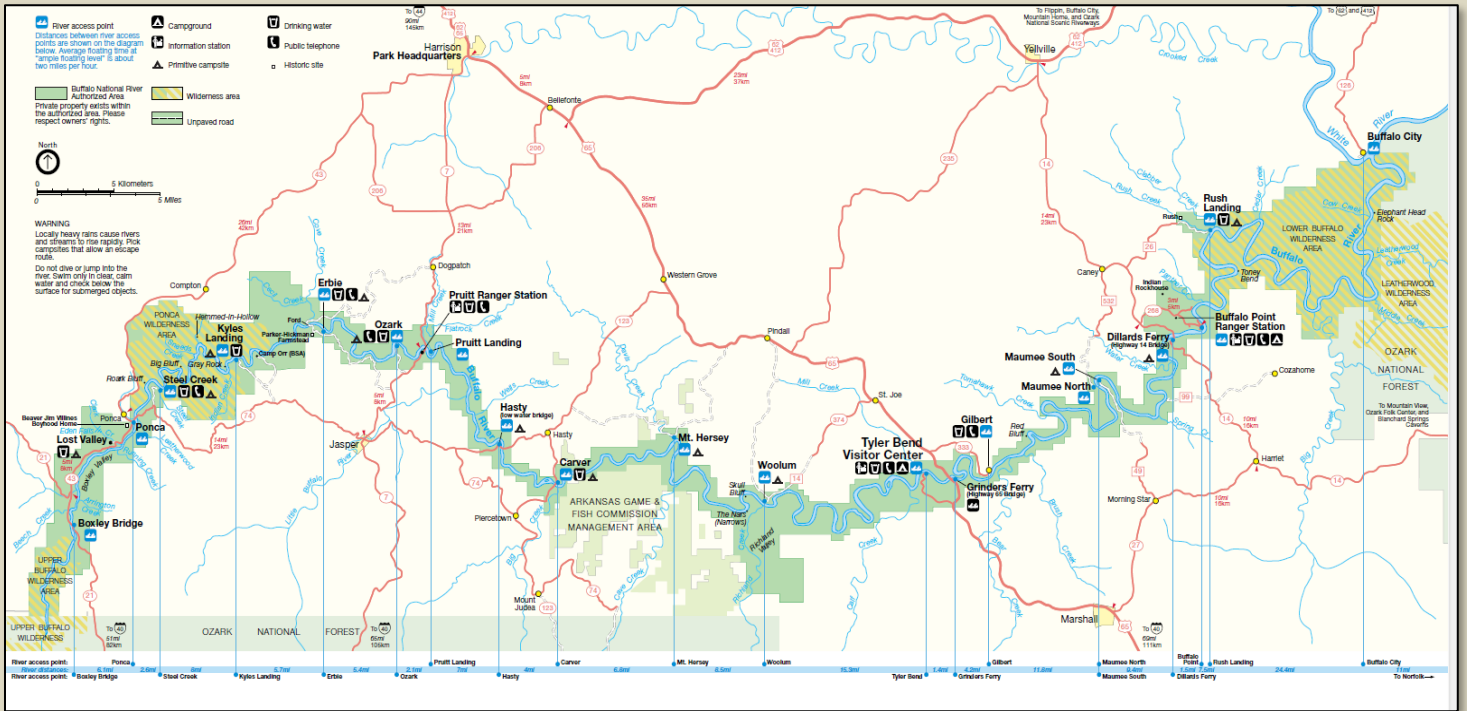


Figure 2. Map of BUFF.

Public land management occurs in a complicated environment that bridges social and environmental factors (Manning, 2010). While scientists and managers usually make decisions based on scientific evidence, visitors and stakeholders often respond to issues based on emotional attachments (Rikoon, 2006). Consequently, identifying visitors' perceptions and attitudes towards current issues is critical to anticipate public responses to the possibility of changing conditions (Arnberger, Eder, Allex, Sterl, & Burns, 2012; Kyle, Graefe, Manning, & Bacon, 2004; Eagly & Chaiken, 1993). This research can provide managers with information about visitors' opinions that directly inform the design of interpretation and public outreach in an intentional and prescriptive manner (Borrie, Davenport, Freimund, & Manning, 2002; McLaughlin & Paradise, 1980). Management decisions are further reinforced when informed through the concurrent evaluation of human values and ecological conditions (Monz, Cole, Leung & Marion 2009).

Objectives

The purpose of this research was to gather baseline information to help support visitor use management and planning at BUFF. Several objectives were executed to inform the primary purpose of the research: 1) evaluate the frequency, type, and temporal and spatial distributions of visitor use at BUFF within and across seasons; 2) determine the relationships between use patterns and socioecological conditions in key unit locations, 3) application of research surveys that captured visitors' desired conditions, 4) survey trails and conditions in the Lower Buffalo Wilderness, and 4) design a sampling and monitoring protocol framework for future implementation which will evaluate efficacy of management actions and general changes in use, desired conditions, and actual conditions.

Methods

Visitor Questionnaires

Researchers distributed three quantitative visitor questionnaires at the Eden Falls trailhead, Kyle's Landing, and Dillard's Ferry. The first questionnaire evaluated visitors' preferences for crowding conditions along BUFF. The second questionnaire investigated visitors' preferences for crowding conditions at Eden Falls and on hiking trails. The third questionnaire examined visitor support (or opposition) for current and potential management strategies in the Lost Valley and Eden Falls area. For both questionnaires, researchers used standard best practices for survey construction, such as those set forth by Vaske (2008) and Dillman (2011).

To gauge visitors' preferences for conditions and crowding, the research team used a norm-based approach underpinned by Normative Theory, which suggests that park visitors have shared beliefs about important aspects of their experiences, including desired experiential, managerial, and ecological conditions (Manning, 2010). These preferences for conditions and 'how things ought to be,' are often referred to as norms (Shelby, Vaske, & Donnelly, 1996). Norms are typically identified in protected area research by asking visitors and/or other stakeholders to identify important aspects of their experience (e.g., what they liked or did not like) and then asking them to rate the acceptability of a range of conditions for that aspect of their experience. Identifying and quantifying norms for ecological, experiential, and managerial conditions often incorporates the concept of indicators and thresholds. According to the Interagency Visitor Use Management Framework (2016), an indicator is a measurable, manageable variable that helps define the quality of a recreation experience, whereas a threshold (or standard) of quality is the minimum acceptable level of an indicator. Applications of normative theory in outdoor recreation management often use 'evaluative dimensions' other than 'acceptability' to determine potential thresholds. For example, visitors to an area may be asked to report norms regarding the conditions they would 'prefer to experience,' the conditions they think 'managers should maintain,' and the conditions under which they would 'no longer visit the area' (i.e., displacement).

Normative theory has helped formulate norm-based thresholds in many contexts with park visitors, including thresholds for the number of snorkelers in key areas at the Great Barrier Reef (Inglis, Johnson, & Ponte, 1999), encounters among snorkelers, divers, and boats at coral reef sites in the Florida Keys (Loomis, Anderson, Hawkins, & Paterson, 2008), visitors and frequency of ferry service to Boston Harbor Islands (Manning, Leung, and Budruk, 2005), vehicles driving on the beach at Cape Cod National Seashore (Hallo & Manning, 2009), and the waiting time to see wildlife (Anderson, Manning, Valliere, & Hallo, 2010).

A threshold and associated evaluative dimensions are often displayed on a social norm curve (see Manning, 2013 for a review). Specifically, the evaluation of various conditions (e.g., acceptability level) are displayed on the y-axis whereas a range of indicator conditions are represented on the x-axis (see Figure 3 for an example social norm curve). Generally, the highest point on the curve represents the preferred or optimal condition. Researchers and managers often consider the neutral line on the social norm curve a threshold, or minimal acceptable condition. All points above the neutral line are often considered the range of acceptable conditions, while points below the neutral line represent conditions that are unacceptable or violate the threshold of the indicator.

The agreement about a norm is referred to as norm crystallization or the amount of consensus about the norm (Manning, 2013). If a stakeholder group has a moderate to high level of agreement about a norm, then data derived from normative investigations can be quite useful for informing management decisions (Krymkowski, Manning, & Valliere, 2009). In this study, researchers used the Potential for Conflict Index (PCI²) to evaluate ‘norm crystallization,’ or the level of agreement regarding visitors’ evaluation of site conditions (Vaske, Beaman, Barreto, & Shelby, 2010). The PCI² spans from zero (maximum agreement; or minimal potential for conflict) to one (minimal agreement; or maximum potential for conflict) and was used to describe the variable’s central tendency and dispersion using visuals (bubbles) incorporated into the social norm curve. According to Vaske et al. (2010), researchers and managers can represent the PCI², or the extent of agreement or consensus regarding a norm, using the size of bubbles. Simply identified by Marin et al. (2011), a small bubble represents less conflict (high consensus) and a larger bubble represents more conflict (less consensus) regarding a norm. Ultimately, if a sample has a moderate to high level of agreement about a norm (medium to small PCI² bubble), then managers can use the information from the normative investigations for management decisions (Krymkowski, Manning, & Valliere, 2009).

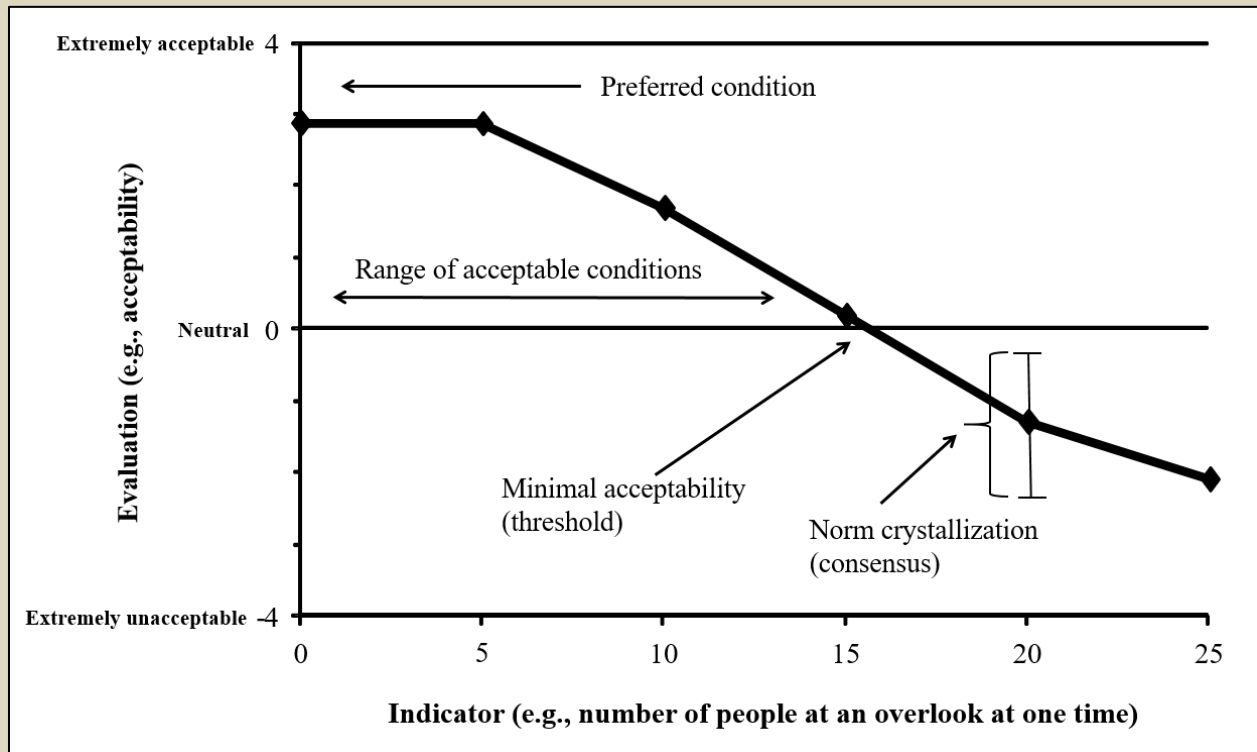


Figure 3. Example of social norm curve to identify visitors’ threshold for number of people at one time at a popular overlook.

Visual approaches to measuring standards of quality were employed using computer-generated photographs to represent a range people at one time (PAOT). Photos were used in the study because they may better communicate or focus attention on the variables intended for evaluation by respondents, particularly when these variables are difficult or awkward to describe in a narrative format (Hallo & Manning, 2009; Manning & Freimund, 2004). Researchers often use visual methods, in the form of pictures, to help identify outdoor recreationists’ normative thresholds (Bullock & Lawson, 2008; Krymkowski, Manning, & Valliere, 2009). Typically, outdoor recreationists’ evaluate social and

ecological conditions by viewing computer-altered photographs depicting varying levels of impacts (Laven & Krymkowski, 2005; Manning, Valliere, & Wang, 1999). Photographs have been found to be useful in determining normative thresholds because they are suggestive surrogates when classifying different impact levels (Newman, Marion, & Cahill, 2001). Furthermore, Manning & Freimund (2004) suggest that the use of photographs for identifying normative thresholds easily and more accurately represent current or possible conditions beyond narrative descriptions.

During May 2016, the research team met with BUFF staff during a two-day workshop in Harrison, Arkansas and within the park unit. The meeting consisted of discussing visitor use management and planning priorities. After these meetings and multiple conversations with visitors, the research team selected five indicators of quality for the study (an indicator is a measurable, manageable variable that helps define the quality of a recreation experience).

1. Crowding at Eden Falls
 - a. Operationalized as people at one time at Eden Falls
2. Crowding at river access areas
 - a. Operationalized as people at one time at a river access area
3. Congestion on the river
 - a. Operationalized as other boats within view at one time on the river
4. Crowding on the river
 - a. Operationalized as number of people encountered on the river during a one-hour period
5. Crowding on trails
 - a. Operationalized as number of people encountered on trail during a one-hour period

When measuring visitors' preferences and thresholds for crowding at Eden Falls, crowding at river access areas, and congestion on the river, visitors were asked to study multiple photographs that depicted a range of conditions from solitude (e.g., no people) to saturation (e.g., large amount of people). Researchers constructed study photographs by taking baseline photographs of river access areas, Eden Falls, and the river with and without visitors. These photographs were aggregated, layered, and modified in Adobe Photoshop to depict a range of conditions that occur or could occur at BUFF. The research team paid special attention to depict crowding and congestion at BUFF, which involved using people, boats, and vehicles in most photographs. The research team opted to include all of these elements in the photographs to more accurately align study photographs with actual conditions at study focus areas, as opposed to displaying photographs with only people, or only boats.

Photographs were presented to visitors within a three-ring binder and ordered randomly and sequentially, depending on the binder. While viewing the photographs, visitors rated each photo by indicating how acceptable it was based on the conditions displayed. Respondents rated photos on a nine-point Likert scale ranging from - 4 ("very unacceptable") to + 4 ("very acceptable"), with a midpoint of 0. Respondents were also asked to indicate the photo showing the level of crowding or congestion that a) management action should occur, b) visitor use should be limited, and c) they would no longer use the area (displacement) (see Figure 4 for an example photo series from Eden Falls).

The 'management questionnaire', which was distributed at Lost Valley, asked participants to assess questions that queried about various current and potential management actions at Lost Valley. Selected in consultation with BUFF managers, specific management actions consisted of a) establish additional parking options, b) create a new campground, c) increase size of roadside pullouts for elk viewing, d)

create new roadside pullouts for elk viewing, e) establish a visitor center, and f) expand existing restroom facilities. Respondents rated questions on a 7-point Likert scale ranging from - 3 (“strongly oppose”) to + 3 (“strongly support”), with a neutral point of 0. Visitors also assigned 100 preference points to these actions, with points segmented and assigned according to the most preferred actions. Additionally, respondents indicated the management action that they preferred the most if only one management action was available.

In all questionnaires, researchers also captured visitors’ past use history (PUH; or past visits) at BUFF, outdoor recreation activities engaged in at BUFF, and general demographics using standard U.S. Census Bureau categories. General demographics included a) zip code of primary residency, b) age, c) race, d) income, and e) education level.

In accordance with institutional and federal policy, researchers used question formats from the National Park Service’s Pool of Known Questions (NPS, 2015) and the Office of Management and Budget approved the questionnaires (OMB# 1024-0224). Both Kansas State University and the University of Utah approved the research methods after review from each Institutions’ Internal Review Board (IRB).

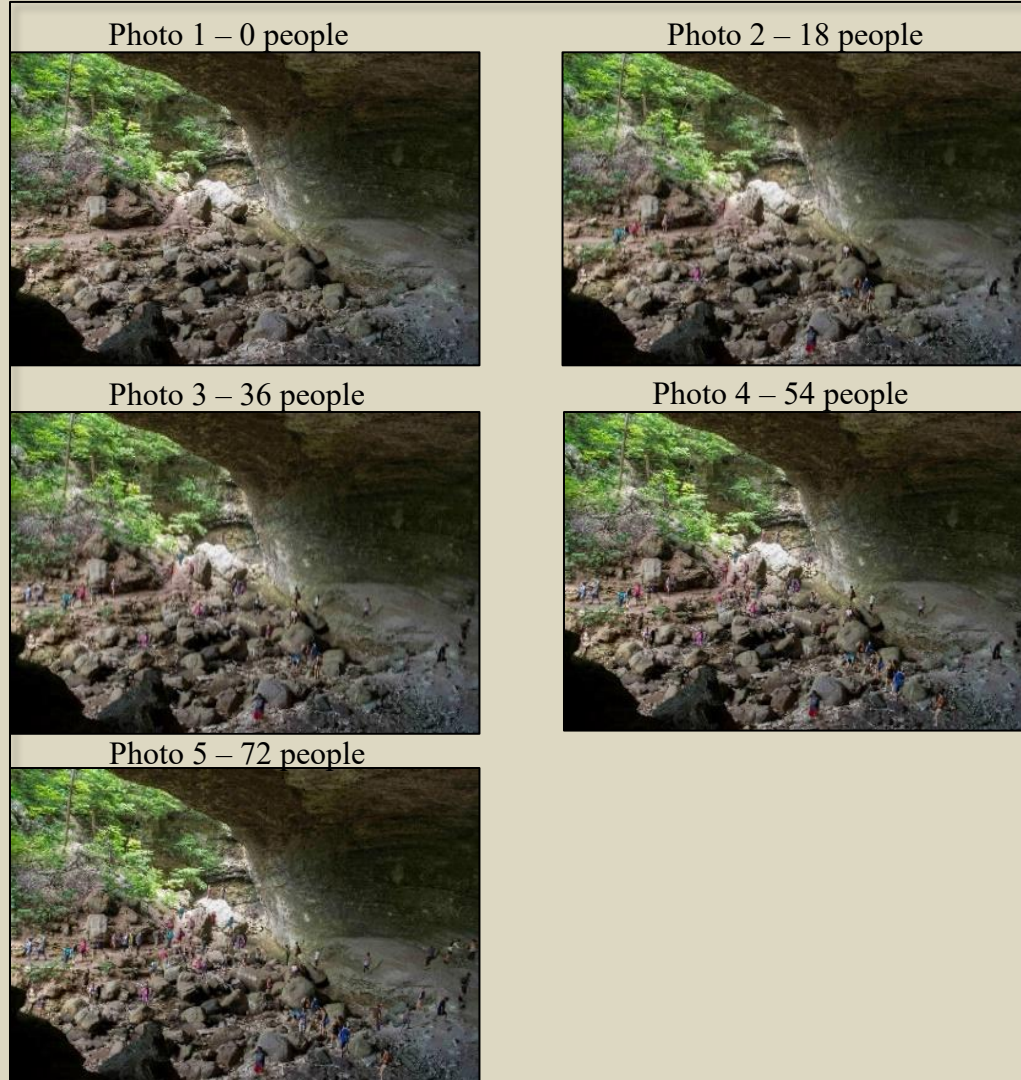


Figure 4. Photos presented to visitors to assess preferences for crowding at Eden Falls.

Questionnaire Sampling Design and Locations

To ensure a representative sample at specific locations across the unit, the researchers used a stratified random sampling procedure, which was stratified across time of day, day of the week, and season to intercept visitors (Table 1) (Vaske, 2008). The questionnaires were administered from August 2016 to August 2017 at Eden Falls trailhead (Figures 5 & 6), Kyle's Landing (Figures 5 & 7), and Dillard's Ferry (Figures 8 & 9). The Kyle's landing location acted as the sampling location for condition at the Ponca access point as well as the Kyle's access point. Data for Ponca was only collected during the spring and summer of 2017, as this access point is not typically used in later times of the year due to low water. Trained research assistants approached each visitor, informed them about the study, and invited them to participate. One respondent from each travel group (e.g., family) completed a questionnaire. The percentage of visitors who agreed to complete the questionnaire was recorded. A trained survey administrator was available to provide assistance or clarification to respondents.

Table 1. *Location sampling schedule.*

Date	Lost Valley Management	Lost Valley Conditions	Kyle's Landing	Ponca	Dillard's
8/4/16					x
8/9/16	x	x			
8/10/16	x	x			x
8/11/16	x	x			x
8/12/16	x	x			x
8/13/16	x	x			
8/15/16	x	x			
10/8/16					x
10/9/16	x	x			x
10/11/16	x	x			
10/12/16					x
10/13/16		x			x
4/10/17			x	x	
4/13/17	x	x	x	x	x
4/14/17			x	x	x
4/15/17			x	x	x
4/16/17					x
4/17/17	x		x	x	
5/25/17			x	x	
5/26/17			x	x	x
5/27/17			x	x	x
5/28/17			x	x	x
5/29/17	x	x	x	x	x
6/16/17					x
6/17/17	x	x			x
6/18/17	x	x			x

Questionnaires were administered via a tablet computer, specifically a Samsung Galaxy Tablet A6 – 7” display, which operated on Android 5.1.1. The questionnaires were designed using Qualtrics Survey Software version 1.3.01, and uploaded to each tablet used in the field. Qualtrics software provides intuitive design that is easy for questionnaire participants to use. Furthermore, Qualtrics compiles the data for efficient data management.

Responses from the questionnaires were entered into SPSS 18.0 Statistical Software Package for analysis. Standard calculations for leverage, kurtosis, and skewness were used to identify statistical outliers and to verify univariate and multivariate normality of the data (Tabachnick & Fidell, 2001). The researchers then addressed the research objectives using social norm curves, descriptive statistics, cross tabulations, and means testing. An alpha level of 0.05 was used for all statistical comparisons.

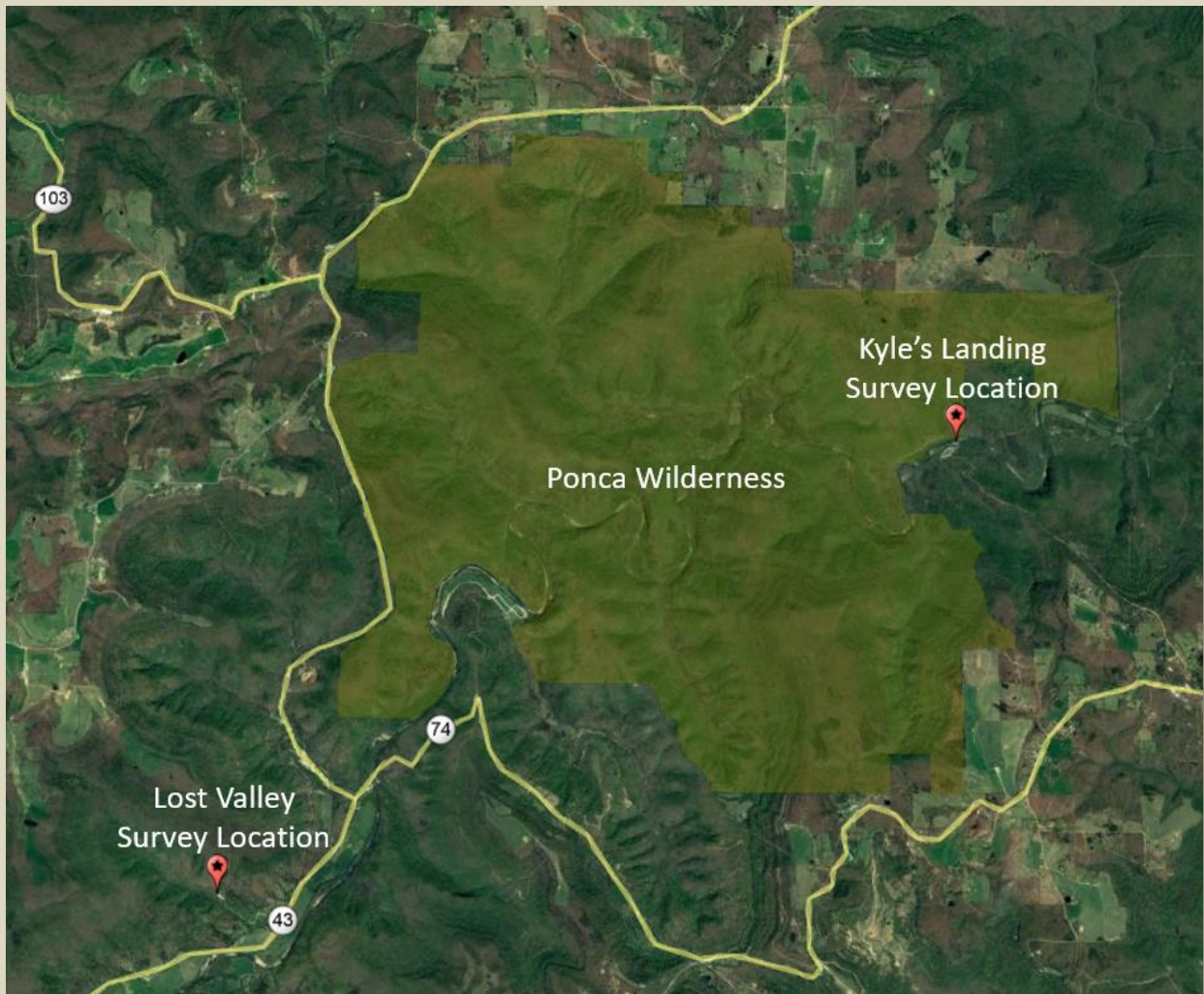


Figure 5. The researchers distributed questionnaires at two locations along the Upper Buffalo River: Lost Valley and Kyle's Landing.



Figure 6. Visitors completing questionnaires at Eden Falls trailhead.



Figure 7. Visitors completing questionnaires at Kyle's Landing.



Figure 8. Researchers distributed questionnaires at Dillard's Ferry to capture visitor preferences for the Lower Buffalo River.



Figure 9. Visitors completing questionnaires at Dillard's Ferry.

Additional Visitor Use Data other than Indicators of Quality

Beyond indicators of quality, there are additional data that can be used to understand the temporal and spatial distributions of visitor use. Understanding these distributions and levels of visitor use are often helpful when attempting to holistically interpret visitor use at a unit. Furthermore, these additional data can provide information to judge if a) visitor levels align (or don't align) with visitor desired conditions and expectations (judged against questionnaire data), b) specific seasons are witnessing increasing or decreasing use, and c) specific sites may warrant additional management attention and/or resources.

Specific to the study detailed in the report, managers and researchers selected and prioritized the following data.

- 1) Amount and distributions of use in the Compton Trailhead parking lot: Operationalized as vehicles at one time
- 2) Amount and distributions of use in the Hathaway Trailhead parking lots: Operationalized as vehicles at one time
- 3) Amount and distributions of use on the entry road to Gilbert Landing: Operationalized as number of interruptions on a vehicle counter
- 4) Amount and distribution of use for trails in the Hemmed in Hollow area: Operationalized as number of interruptions on a trail counter
- 5) Amount and distribution of use for trails in the Indian Rockhouse area: Operationalized as number of interruptions on a trail counter

Human Behavior Cameras and Parking Lot Cameras

The locations of the Human Behavior Cameras (HBCs) and Parking Lot Cameras (PLCs) are displayed in Figures 10, 15, and 18. Pictures of the cameras in the field are displayed in Figures 11, 12, 13, 14, 16, 17, 19, 20, and 21. The researchers stationed HBCs for the entire duration of the year of data collection at the following locations: Eden Falls (3 HBCs displayed in Figure 11), Ponca (1 HBC displayed in Figure 12), Kyle's Landing (1 HBC displayed in Figure 13), Hasty (2 HBCs displayed in Figures 16 & 17), and Dillard's Ferry (1 HBC displayed in Figure 19). The researchers stationed PLCs at Compton Trailhead (1 PLC displayed in Figure 14) and Hathaway near the Lower Buffalo Wilderness Area (2 PLCs displayed in Figures 20 & 21). The researchers used a combination of cameras: Spypoint D11 cameras and Moultrie M-888 cameras. Both of these camera types have a long battery life enabling the cameras to continually take pictures in the field for months. These cameras captured high definition photos of visitor use conditions every 15 minutes from sunrise to sunset across August 2016 to August 2017. The photo point (i.e., HBC camera location) was selected to represent a broad viewshed of the area that allows for use levels to be visually depicted, specifically for crowding conditions and vehicles in parking lot at one time. Cameras were secured with locks and camouflaged appropriately with natural and built devices. The cameras stored data on SD memory cards (16GB capacity), which were periodically downloaded, on average every two months, to a laptop computer using a USB 3.0 SD card reader.

In the lab, each photograph was visually inspected by a team of research assistants using TimeLapse2 software (Timelapse2, 2016). This software package enabled research assistants to inspect each photo for distinct attributes such as the number of people, boat, and vehicles while efficiently recording

anomalies in the photographs (e.g., undesirable weather). The software determines locational changes in each picture and magnifies for rapid inspection of each photo. The TimeLapse2 software saves the photo metadata such as the identifier, date, time, and crowding or parking lot conditions in a MS Excel spreadsheet.

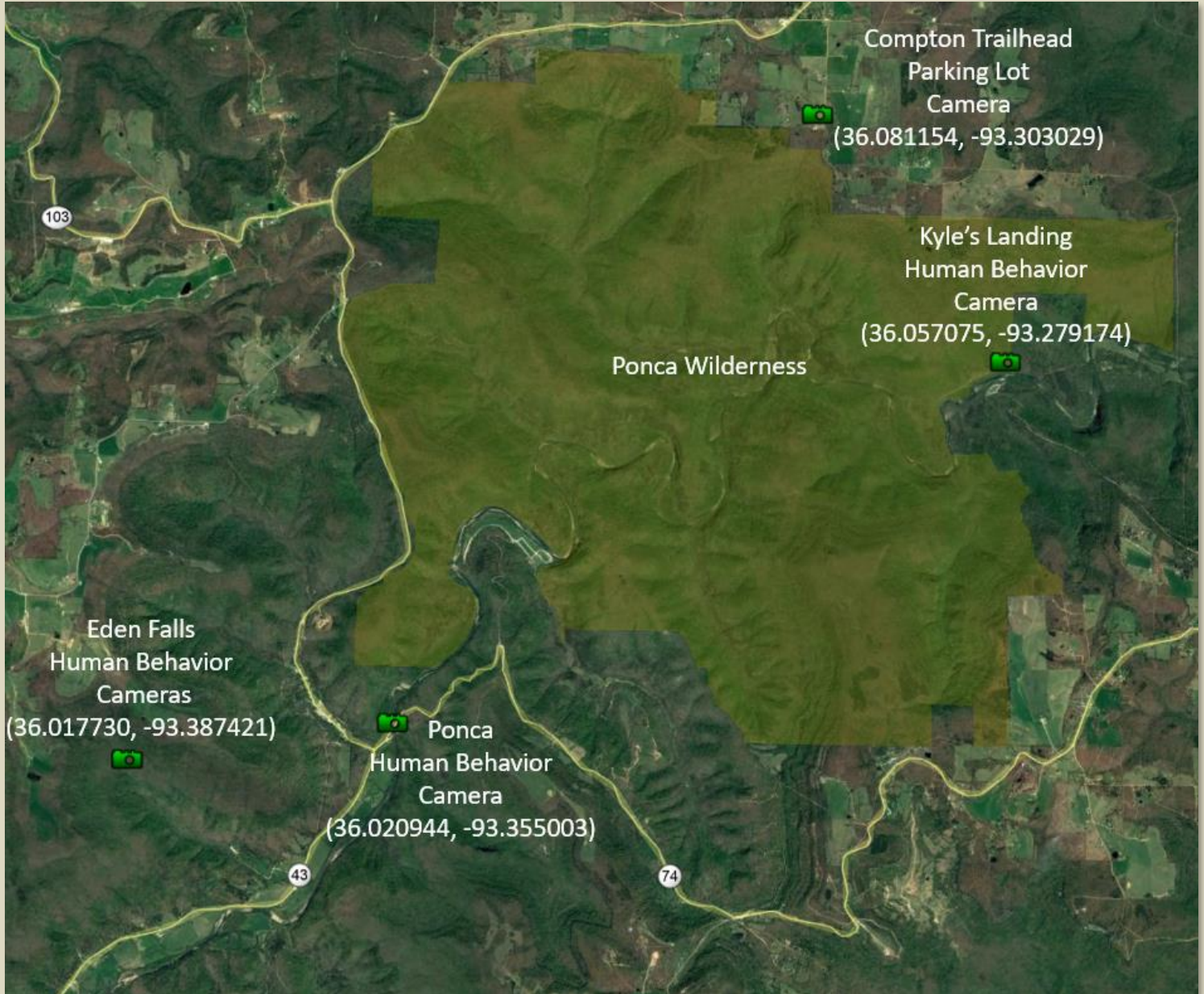


Figure 10. The Upper Buffalo River Human Behavior Camera locations.



Figure 11. The locations of the three HBCs at Eden Falls (36.017730, -93.387421). Each HBC was aimed at Eden Falls and the approaching trail similar to the view displayed in Figure 4. Three cameras were used and photographs later aggregated to ensure accuracy in capturing conditions.



Figure 12. Location of Ponca HBC (36.020944, -93.355003).



Figure 13. Location of HBC at Kyle's Landing (36.057075, -93.279174).



Figure 14. Location of PLC at Compton Trailhead (36.081154, -93.303029).

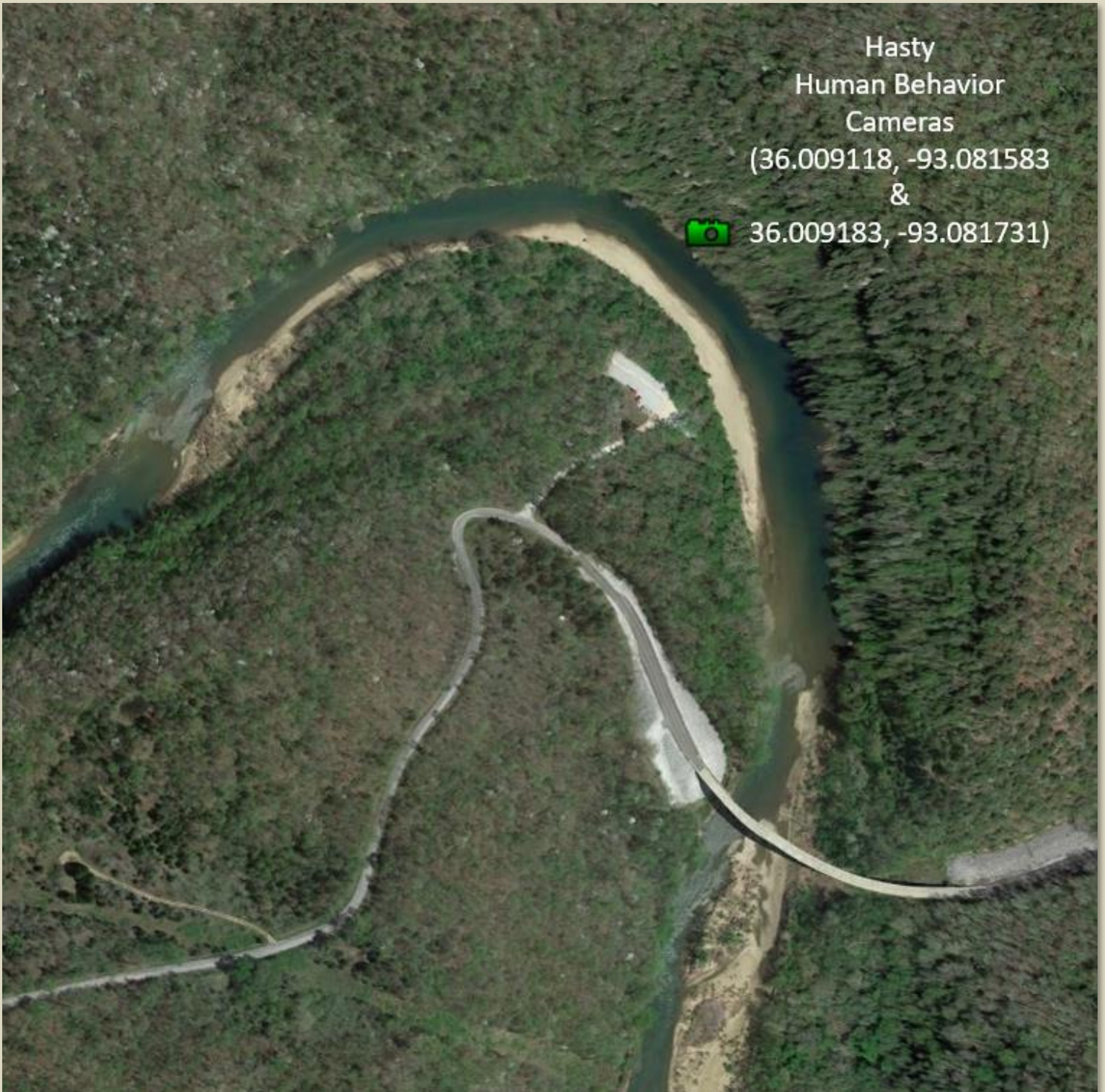


Figure 15. The researchers stationed two HBCs at Hasty.



Figure 16. Location of Hasty HBC 1 (36.009118, -93.081583).



Figure 17. Location of Hasty HBC 2 (36.009183, -93.081731).

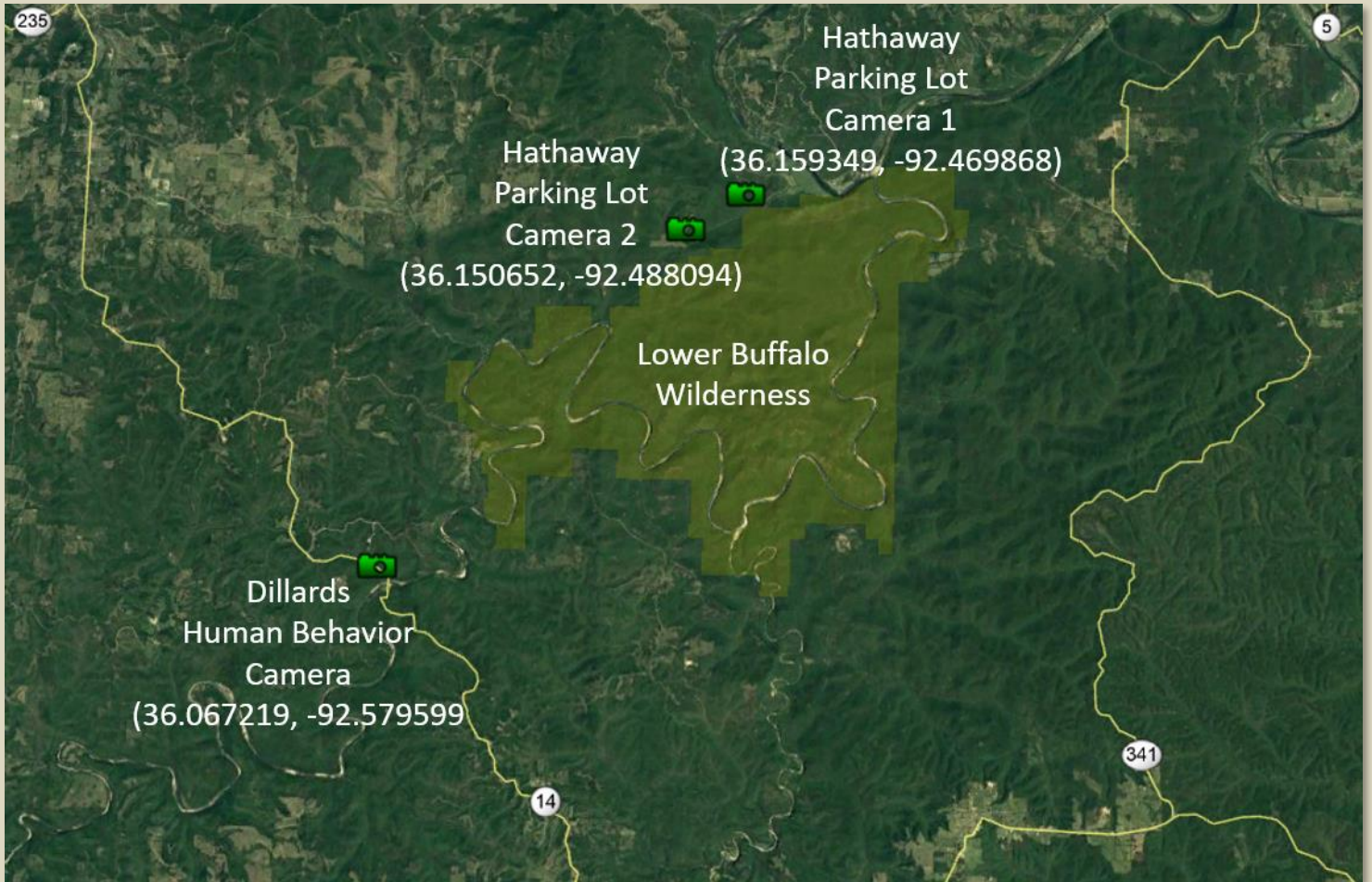


Figure 18. The Lower Buffalo River camera locations.



Figure 19. Location of Dillard's Ferry HBC (36.067219, -92.579599).



Figure 20. Location of Hathaway PLC 1 (36.159349, -92.469868).



Figure 21. Location of Hathaway PLC 2 (36.150652, -92.488094).

Trail Counters

The researchers used infrared trail counters to gather temporal patterns of use at Hemmed in Hollow (Figures 22 & 23), Indian Rockhouse (Figures 24, 25, & 26), and Gilbert (Figures 27, 28, & 29). These counters were deployed from August 2016 to August 2017. To ensure adequate coverage, researchers deployed two trail counters at each of these locations. At Hemmed in Hollow, one trail counter was stationed along the trail between Compton Trailhead and Hemmed in Hollow Falls to determine the frequency and timing of visitors traveling from the Trailhead to the Falls. The second trail counter was located between Buffalo River and Hemmed in Hollow Falls to capture the frequency and number of visitors hiking from the River to the Falls. This counter also captured visitors that departed from the Trailhead and continued to the river after viewing the Falls.

The Indian Rockhouse trail is a loop and each side of the loop was evaluated for frequency and amount of use by using two trail counters. Each trail counter at Indian Rockhouse was located approximately one-half mile away from the Indian Rockhouse trailhead on opposite sides of the trail loop. At Gilbert each trail counter was stationed approximately 20 yards from the landing but on opposite sides of the road to gather temporal patterns on each side of the road.

The researchers used TRAFx Trail Counters. The TRAFx trail counters have a long battery life (up to four years) and are suitable to be left outside, even during inclement weather (TRAFx trail counters can function from -40F – 131F). The TRAFx trail counters detect an infrared signature of a warm moving object (TRAFx Research Ltd., 2011) crossing the infrared beam emitted by the unit. Each moment an infrared signature is detected the trail counter records a count with a time-stamp on its internal hard drive. All six trail counters were periodically checked throughout the year for proper positioning, battery assessment, and downloading of trail counter data. The data was downloaded as a spreadsheet (.csv), which can be opened in MS Excel. The researchers used MS Excel to analyze the exported spreadsheets from each trail counter. The researchers analyzed hourly, seasonal, and annual data patterns.

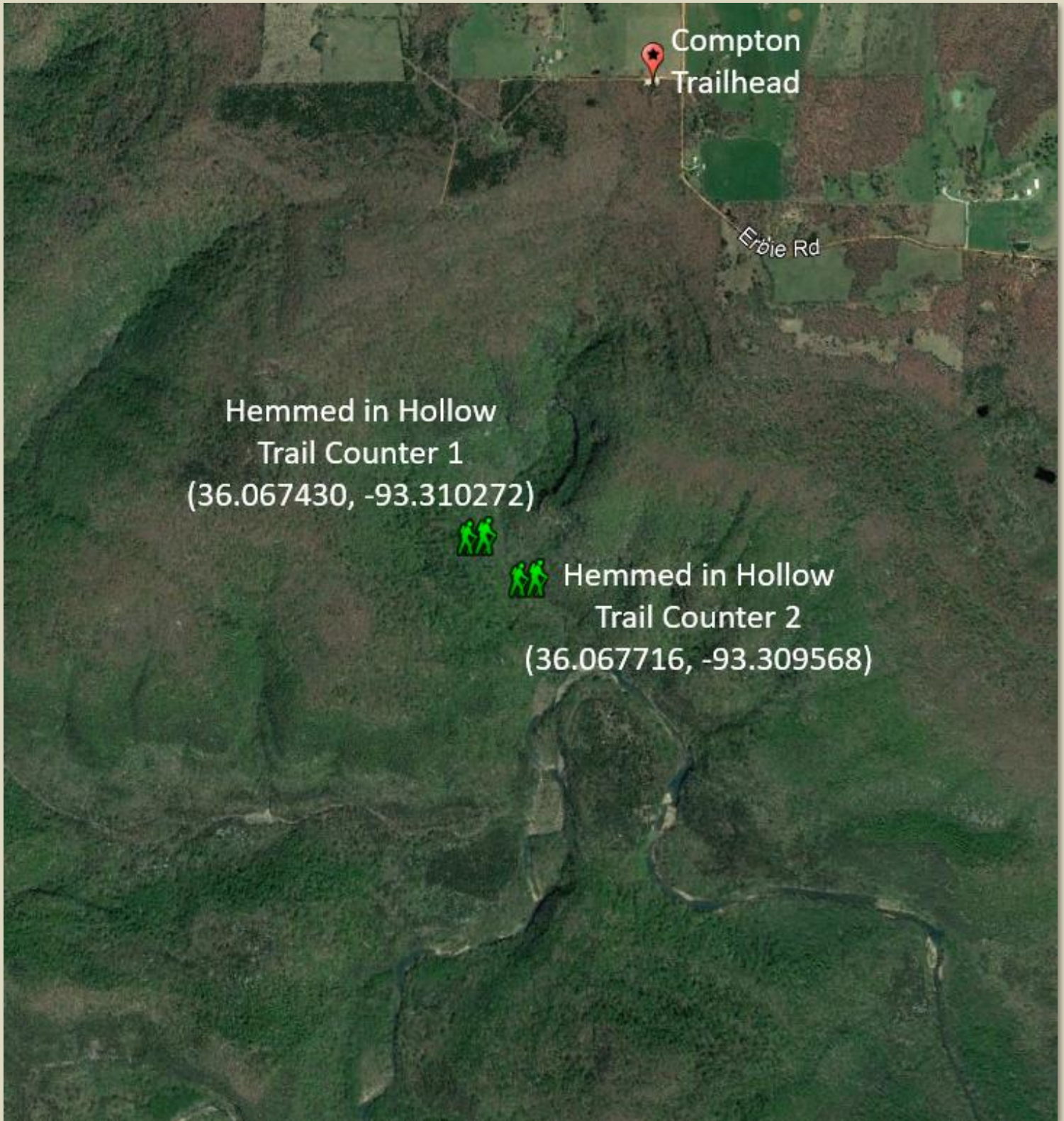


Figure 22. The locations of the two trail counters stationed at Hemmed in Hollow.



Figure 23. Location of Hemmed in Hollow Trail Counter 2 (36.067716, -93.309568).

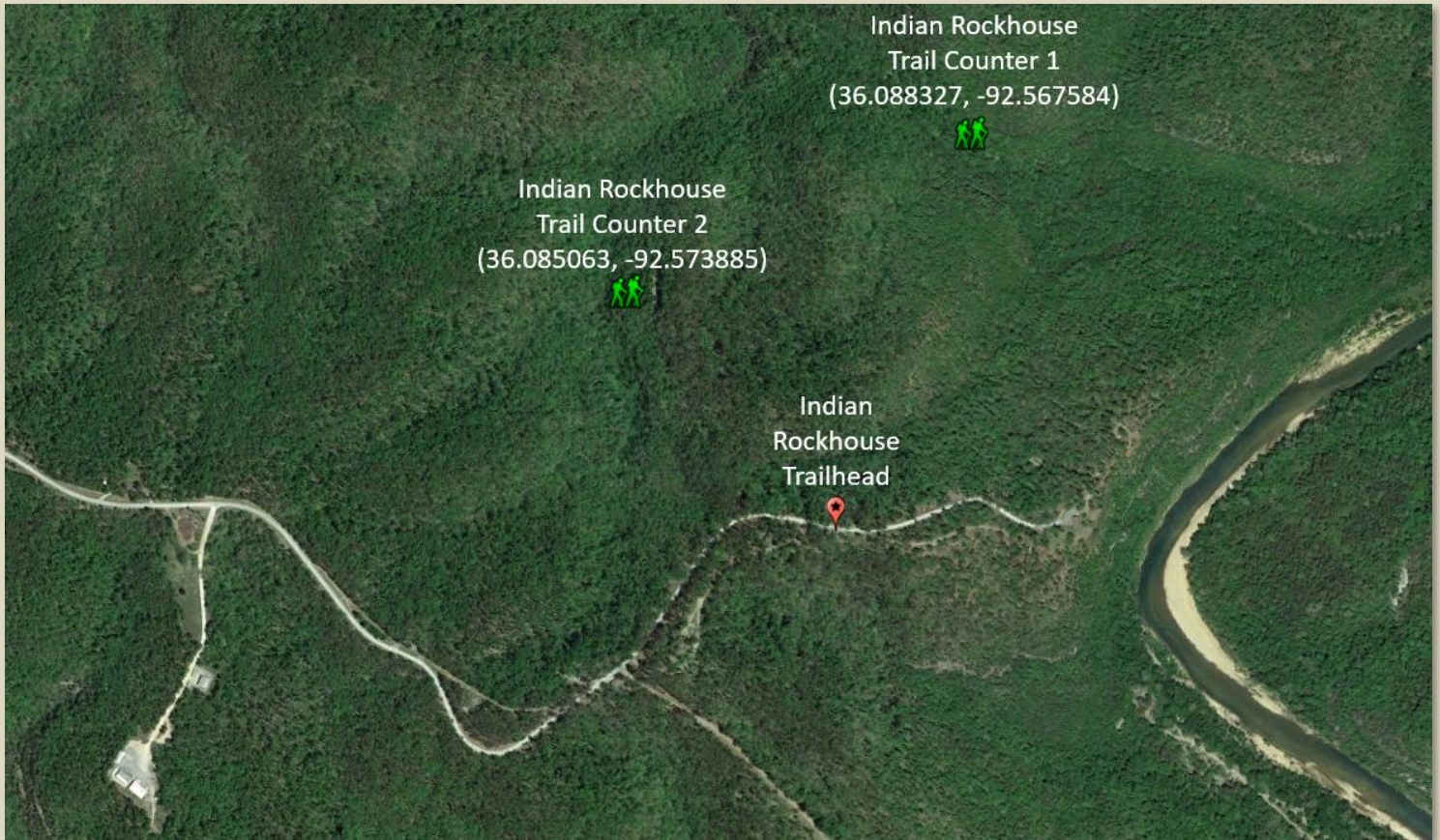


Figure 24. The locations of the two trail counters stationed at Indian Rockhouse.



Figure 25. Location of Indian Rockhouse Trail Counter 1 (36.088327, -92.567584).



Figure 26. Location of Indian Rockhouse Trail Counter 2 (36.085063, -92.573885).



Figure 27. The locations of the two trail counters stationed at Gilbert.



Figure 28. Location of Gilbert Trail Counter 1 (35.987033, -92.715492).



Figure 29. Location of Gilbert Trail Counter 2 (35.987039, -92.715351).

Surveying Trail Conditions in the Lower Buffalo Wilderness Area

Surveying of the trails in the Lower Buffalo Wilderness Area began with determining the location of the trailheads in the Lower Buffalo Wilderness. At each trailhead a researcher surveyed each trail with GPS to determine the network of trails located in the Lower Buffalo Wilderness (Figure 30). Each trail was walked while GPS tracking until the trail dissipated and the researchers could not find the trail. The researchers carried survey-grade GPS units that recorded continuous waypoints along the trails. Field surveying occurred in March of 2017 and was selected because a) vegetation was less likely to obstruct the ability to identify the trail, b) some trail conditions are more easily assessed during low vegetation periods, and c) visitor use was low allowing for assessment without interrupting the visitor experience. The data was imported into ArcMap 10.3, which was used to map the network of trails and trailheads in the Lower Buffalo Wilderness Area. The data in ArcMap 10.3 was exported as a KMZ file and opened in Google Earth to create an interactive map for the managers at BUFF.

While surveying each trail in the area, researchers used a rapid assessment technique to locate points along the trail where visually noticeable recreation-related impacts occurred to the trail tread. At these impact locations, the researchers used standardized trail measurements for trail width, maximum incision, muddiness, height of vegetation above trail, trail braiding, and rugosity (see the description of

these measures below). The identification of these impact locations and the measured conditions serve two purposes. First, they illuminate specific trail locations where management action may be needed to mitigate future impacts and resolve current impacts through trail maintenance and/or redesign. Second, the data serves as a baseline to judge future conditions and assessments. The following techniques were used to measure trail tread conditions at identified impact locations.

Trail width is the gap in vegetation growth where the trail resides and is central to supporting trail traffic (Wimpey & Marion, 2010). Trail width is measured with a standard tape measure extended across the trail tread from boundaries defined by visually obvious trampling disturbance (Dale & Weaver, 1974). Excessive trail width means there is a larger areal extent of impact to vegetation, organic litter, and soil, possibly decreasing the aesthetics of the trail (Wimpey & Marion, 2010).

Trail incision is the depth of the main tread in relation to the sides of the trail (Marion & Leung, 2001). Researchers and managers generally measure incision by temporarily positioning a transect line that is perpendicular to the trail tread. The transect line is attached to stakes placed at the trail borders and configured vertically to represent the post-construction, pre-use tread surface (Marion, Leung, & Nepal, 2006). Trail incision is the maximum measurement taken from the transect line to the lowest point of the trail (Marion et al., 2006). Incision correlates with soil loss caused by wind and water erosion, compaction, and soil displacement (Olive & Marion, 2009). Significant soil loss can cause hikers to wander laterally, widening the trail and causing greater vegetation and soil loss over time (Bryan, 1977; Wimpey & Marion, 2010).

Muddiness occurs on flat sections of trail that retain water and where the terrain lacks drainage (Marion & Leung, 2001). Muddiness is often measured by identifying the lineal extent of the muddy area using a measuring wheel (Moore, Leung, Matisoff, Dorwart, & Parker, 2012). Muddiness may cause hikers to circumnavigate the muddy area, which can result in trail widening and/or vegetative trampling to avoid the mud (Marion, 1994). Muddiness may also increase the difficulty of travel, particularly in relation to hiking speed and stability.

Height of vegetation above the trail is analyzed primarily for horseback rider clearance. United States Forest Service recommends a minimum of 10ft clearance and a preferred clearance of 12ft (United States Forest Service, 2009). Vegetation that hangs low over trails may cause equestrian users to navigate off trail to avoid low hanging vegetation, which can contribute to trail braiding. Vegetation height was assessed for trail clearance in the Lower Buffalo Wilderness using a telescoping 12ft pole.

Trail braiding is identified when a single trail separates into parallel treads (Marion & Leung, 2011). Trail braiding is typically seen in muddy locations where multiple treads have developed to circumnavigate the muddy location. Trail braiding also contributes to trampling of vegetation, and may diminish the aesthetics of the proximal area.

Rugosity is the roughness of the trail tread, generally caused by soil loss. It is the variance of the trail tread across a transect line that is situated perpendicularly to the trail tread. The rougher the trail is typically results in more variance and higher measures of rugosity. A smooth trail typically has low rugosity measures. Exposed rocks and roots in the tread can contribute to

increased rugosity and hiking difficulty (Wimpey & Marion, 2010). Researchers and managers measure rugosity using a three-step process. First, stakes and a transect line are configured as described for the trail incision measurement (Olive & Marion, 2009). Second, at fixed intervals (e.g., 10cm) vertical measurements are taken from the transect line to the tread surface (Wimpey & Marion, 2010). Third, the variance of these vertical measurements is calculated as a measure of tread rugosity (Wilson & Seney, 1994; Wimpey & Marion, 2010). Rugosity often causes hikers to seek smoother terrain, which means possibly hiking away from the tread to avoid rough areas (Wimpey & Marion, 2010). Rugosity can slow and distract hikers because they must be cognizant of foot placement to avoid rocks and roots that increase the chance of tripping and falling (Moore et al., 2012).



Figure 30. Lower Buffalo Wilderness trail surveying.

Results

During sampling, 1,288 visitors completed a questionnaire, yielding a response rate of 81.75% and achieving a 2.73% confidence interval at the 95% confidence level. This completion amount represents 1,288 visitor group (one person per group completed a questionnaire) with an average travel party size of 6.27 (median = 4.00), which equates to approximately 8,076 visitors' experience. The sampling stratification procedures, high response rate, and low confidence intervals suggest that the resulting sample is robust and appropriately represents the visiting population of BUFF.

Overall Demographics of Visitors

The average age of respondents was 48 years. Gender orientation was evenly split with 49.6% respondents identifying as male, 50.1% identifying as female (0.3% other). The sample had varying educational levels, with most participants choosing the following three levels of obtained education: 17.5% completed some college, 32.2% received a four-year degree, and 23.1% reported receiving a graduate or professional degree. The sample also had varying levels of household income, with most participants choosing the following three levels of household income: 16.5% reported a household income of \$50,000 to \$74,999, 14.0% reported a household income of \$75,000 to \$99,999, and 13.7% reported a household income of \$100,000 to \$149,999. Many respondents (86.6%) self-identified as white, and 4.6% self-identified as Hispanic or Latino/Latina, with the rest of participants self-identified as other races. Respondents had varying levels of total household income. Most respondents were from Northwest Arkansas (Figures 31, 32, & 33).

Zip Code Data

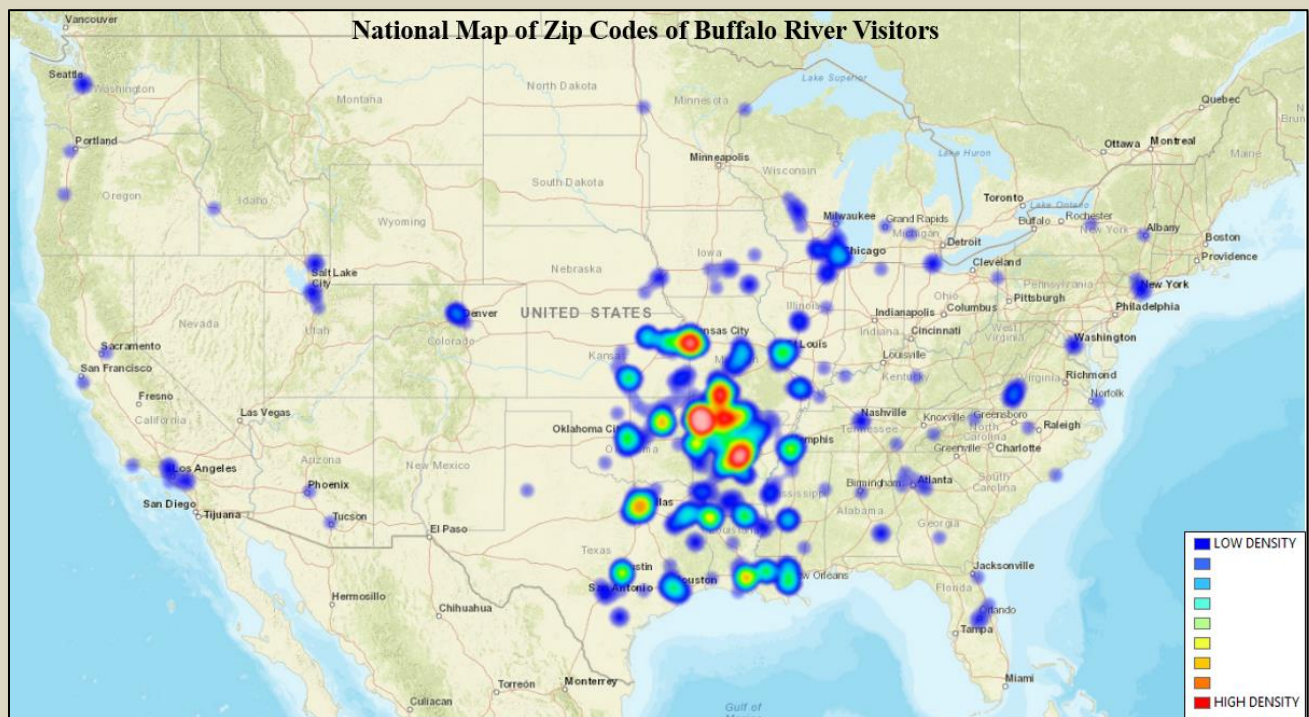


Figure 31. Map of the United States of zip codes reported by visitors who completed a questionnaire.

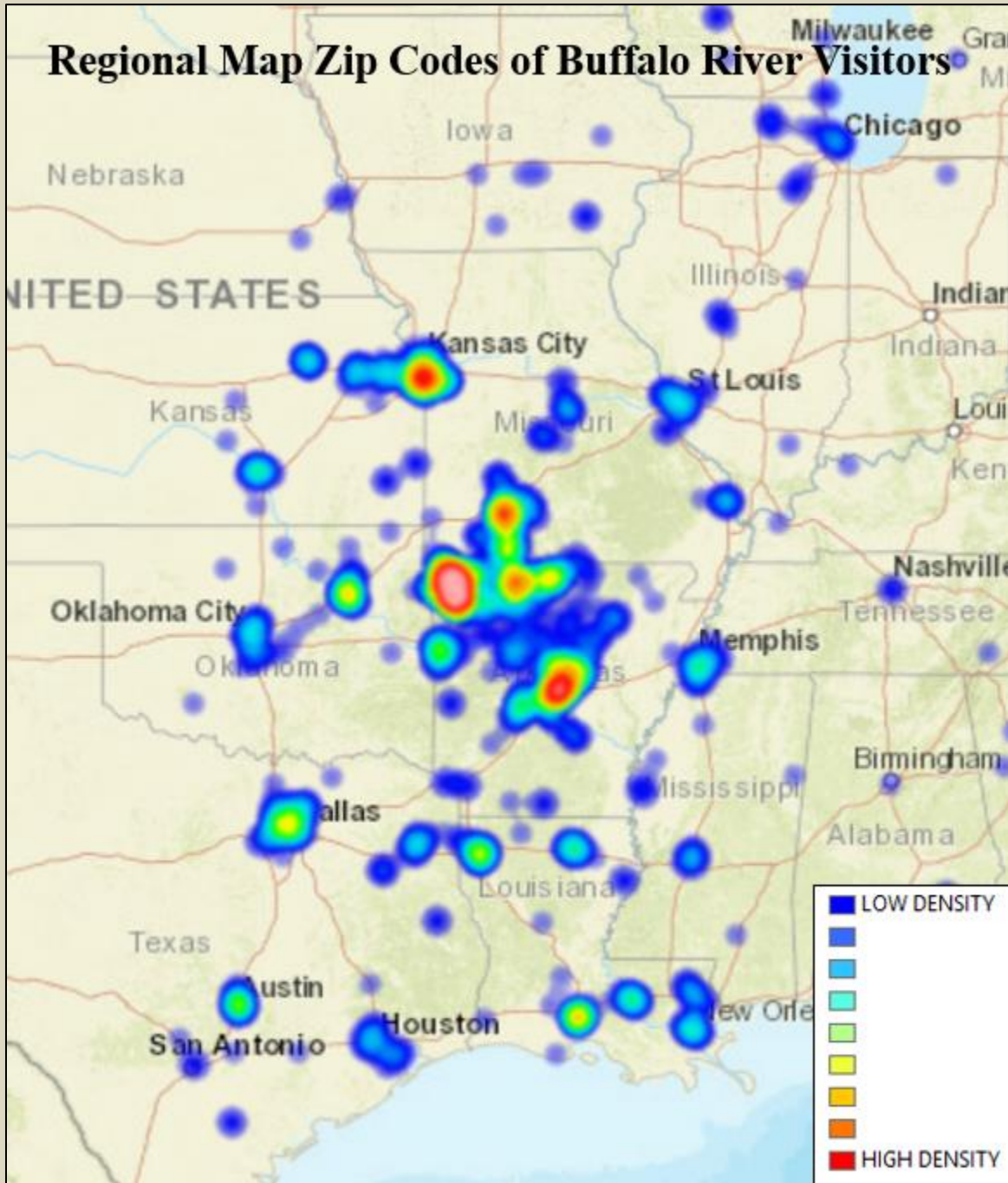


Figure 32. Regional map of zip codes of BUFF visitors.

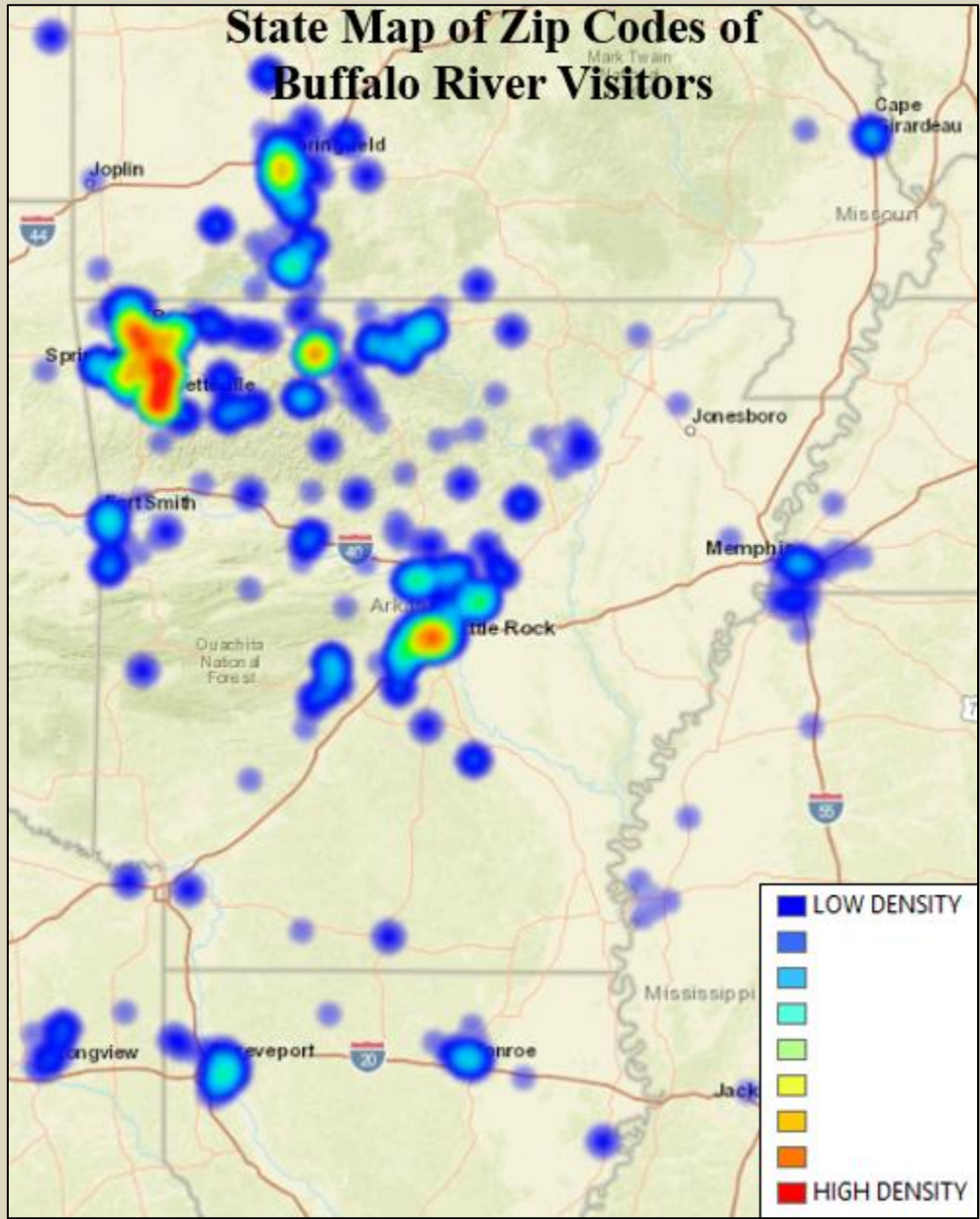


Figure 33. Zip code map of Arkansas and surrounding areas of BUFF visitors.

Boxley/Lost Valley and Eden Falls

Visitor Activities

Visitors come to the Lost Valley and Eden Falls area of BUFF to pursue various activities. Questionnaire respondents intercepted at the Eden Falls trailhead reported that hiking was the primary reason for visiting BUFF. The second most popular activity for visiting BUFF was viewing nature/wildlife. The third most popular activity was camping (Table 2).

Table 2. *Visitors to Lost Valley listed the following activities for the primary reasons they come to BUFF.*

Activity	% of sample
Hiking	80.82
Nature/ Wildlife	33.02
Camping	19.18
Canoeing	10.38
Visit Historical Sites	7.86
Kayaking	6.92
Tubing	3.14
Horseback Riding	2.2
Other	4.09

Visitors to the Lost Valley and Eden Falls area reported participating in various activities during the same trip at BUFF. Hiking was the most popular activity and the second most popular activity was nature/wildlife. Camping was the third most popular activity (Table 3).

Table 3. *Visitors to Lost Valley participated in the following activities at BUFF during the same trip they responded to the questionnaire.*

Activity	% of sample
Hiking	68.55
Nature/ Wildlife	41.19
Camping	16.98
Visit Historical Sites	12.58
Canoeing	5.35
Kayaking	4.40
Tubing	2.52
Horseback Riding	1.26
Other	5.35

Visitors to the Lost Valley and Eden Falls area participated in various activities during the last 12 months at BUFF. Hiking was the most popular activity that questionnaire respondents participated in and the second most popular activity was nature/wildlife. Camping was the third most popular activity (Table 4).

Table 4. *Visitors to Lost Valley participated in the following activities at BUFF during the past 12 months.*

Activity	% of sample
Hiking	46.23
Nature/ Wildlife	28.93
Camping	18.24
Visit Historical Sites	11.32
Canoeing	10.06
Kayaking	9.43
Tubing	3.77
Horseback Riding	2.20
Other	4.09

The researchers evaluated Lost Valley visitors about crowding by first asking about generalized crowding at BUFF (Table 5). The results suggest that the majority of visitors reported experiencing moderate or low levels of crowding.

The question was stated as follows:

“Using the scale below, please rate the level of crowding you experienced at Buffalo National River today. Please circle the number that best matches your response”

Not Crowded		Moderately Crowded				Extremely Crowded		
1	2	3	4	5	6	7	8	9

Table 5. *Questionnaire respondents assessed crowding at BUFF on the same day as they took the questionnaire.*

	Percent
1 Not Crowded	25.3
2	16.6
3	21.1
4	15.9
5 Moderately Crowded	13.6
6	2.3
7	2.3
8	1.6
9 Extremely Crowded	1.3

Note. Mean = 3.08 and SD = 1.83

Past-Use History

Lost Valley/Eden Falls visitors completed questionnaire sections regarding past use history at BUFF. Specifically, visitors indicated a) how many days in the last month they have used BUFF for outdoor recreation activities; b) how days in the last year they have used BUFF for outdoor recreation activities; and c) how many years (total) they have used BUFF for outdoor recreation activities. The researchers used the days visited in the last year and the total years visiting to segment visitors based on similar responses. This segmentation is referred to as a K-means cluster analysis and resulted in four types of visitors using BUFF and intercepted in the Eden Falls area (Figures 34, 35, 36, and 37).

The results reveal that 27% of visitors to the Eden Falls area using BUFF for outdoor recreation are first time visitors (Figure 34). On average, 60% of visitors have used BUFF four days a year and for four years (low annual visitation and limited visitation history). Approximately 12% of the visitors are characterized by relatively low annual visitation but an extended visitation history, averaging five visitation days at BUFF annually but 29 years of visit history. The smallest visitor group (1%) reported high annual visitation (63 days annually, on average) and an extended visitation history (20 years, on average). Overall, these results suggest that the majority of visitors to BUFF intercepted in the Eden Falls area visit four days or less a year, on average.

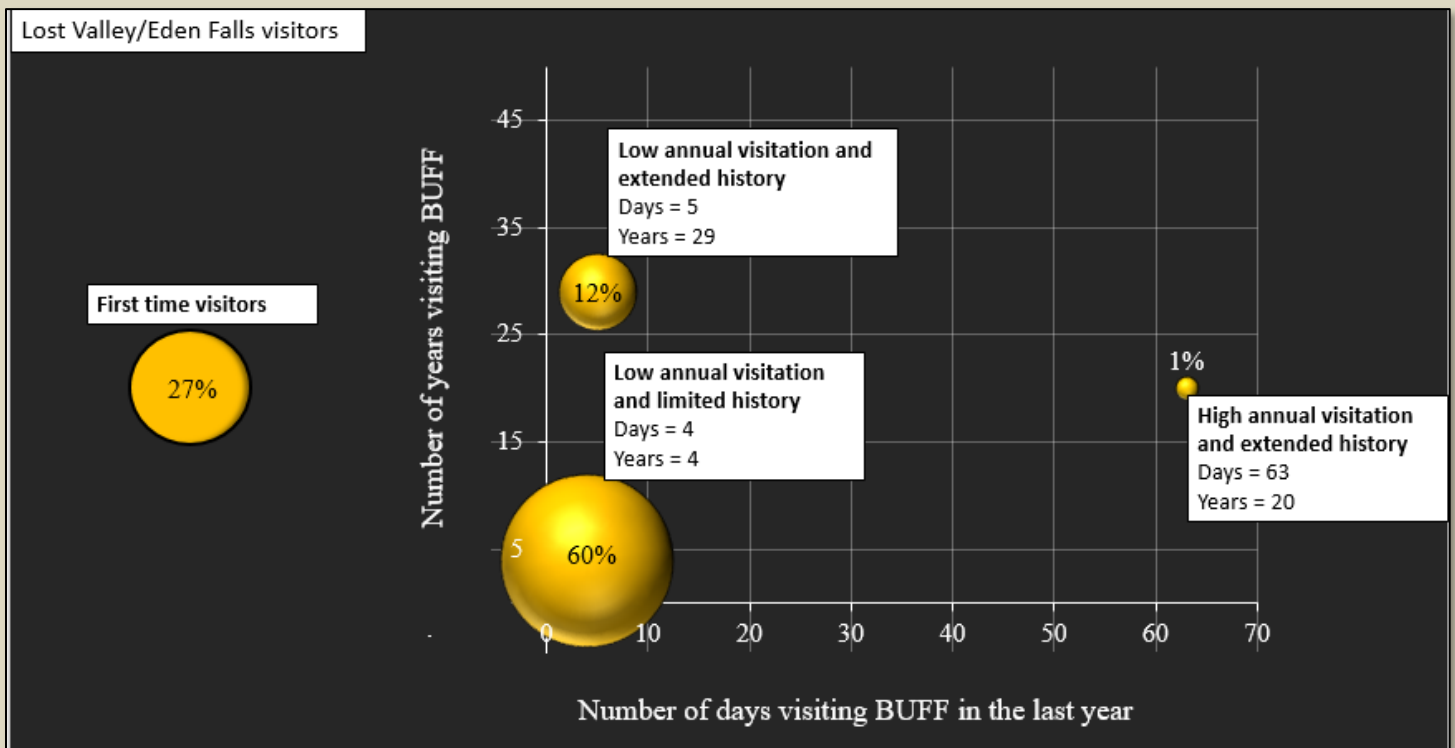


Figure 34. The four primary groups of visitors at BUFF as intercepted in the Eden Falls area.

Note. Results based on K-means cluster analysis using a four-factor solution with cluster centers differing at $p < 0.05$. All clusters analyzed with a one-way analysis of variance in respect to average race, income, location of residency, age, and education with no identified differences between clusters. The four primary groups of visitors to Lost Valley: 1) first time visitors; 2) low annual visitation and extended history; 3) low annual visitation and limited history; and 4) high annual visitation and extended history.

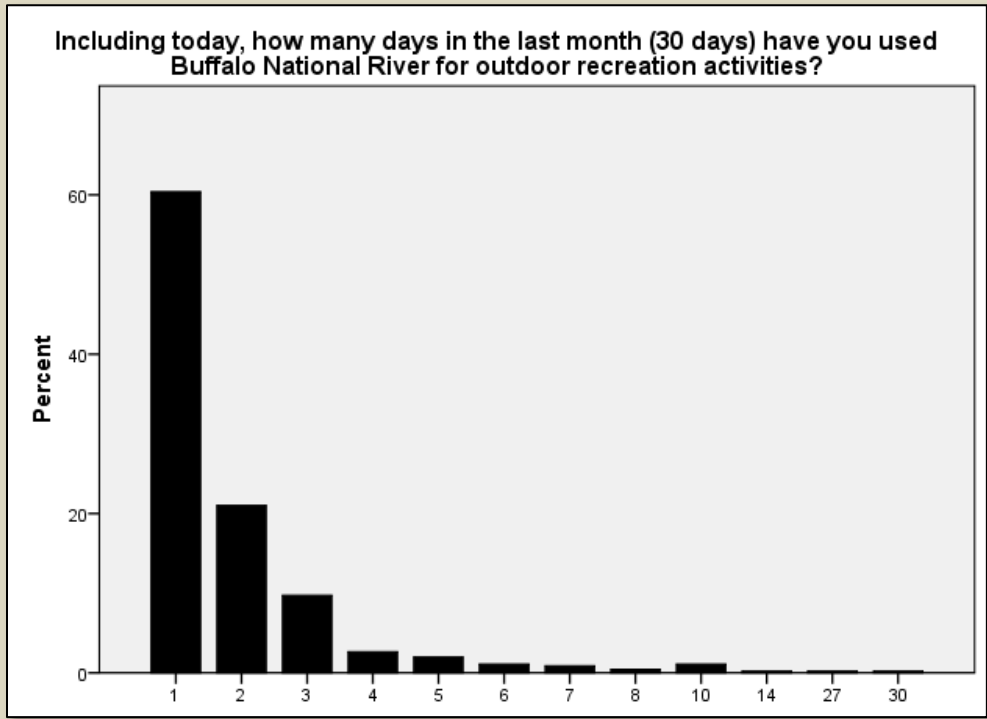


Figure 35. Past-use history for the last month (30 days).

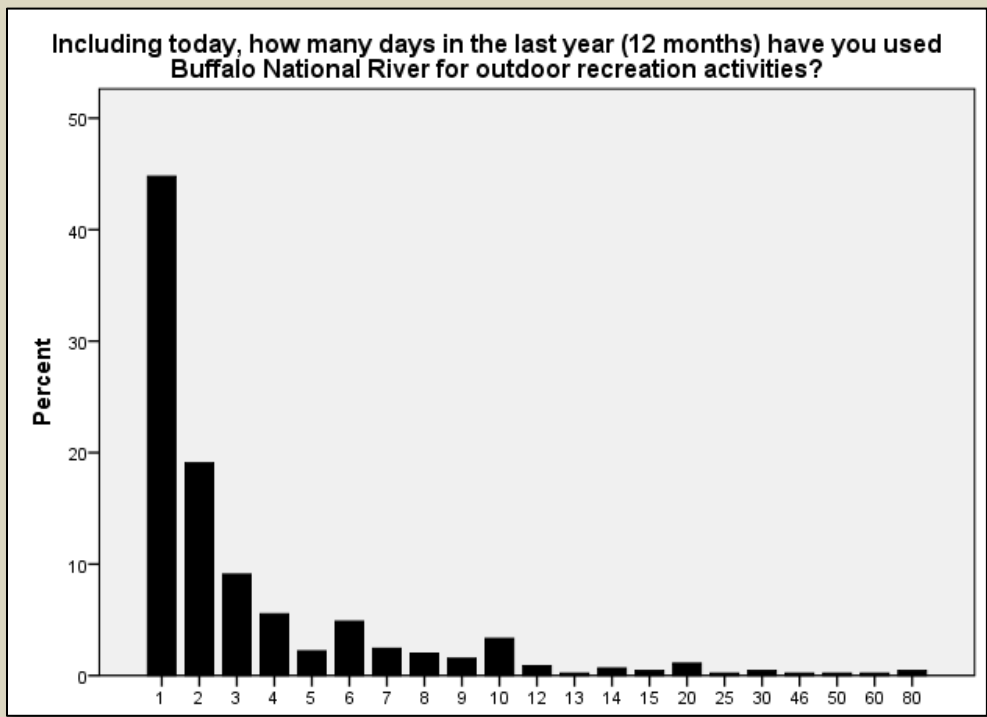


Figure 36. Past-use history for the last year (12 months).



Figure 37. Past-use history for total number of years.

Travel Party Size

Visitors to Lost Valley frequently visit the area with other people. The average party size was 4.38 and a median of 4.00. The most common travel party size consisted of two people. The next most common travel party size was four people. The third most common travel party size was five people. Single person travel party size was uncommon.

Opinions about Potential Management Actions

Opinions of potential management actions were investigated several ways. First, respondents assigned preference points to various management actions (all preference points were required to add up to 100) (Table 6, Figure 38). Second, the researchers employed a seven-point scale to determine the level of support or opposition for potential management actions (Table 7). Third, respondents chose the potential action that favored the most (Figure 39). Finally, these three measures were indexed using a unit-weight summative index (Table 8, Figure 40), referred to here forward as the Management Action Index for Lost/Boxley Valley. This final index represents visitors' desire for management action and displays the percent of management effort and resources that could be assigned to each potential management action if all management actions were implemented. ***The Management Action Index is only derived from visitors' preferences and responses and should be incorporated into planning as only one information input.*** Policy, legal mandates, available resources, and larger park planning efforts should be considered, and in many cases weighted more substantially than the index provided here.

This caveat aside, the Management Action Index indicates that creating a new campground in the area and establishing a visitor center are the two most preferred actions by visitors, resulting in a recommendation of 31% and 24% of potential management effort and resources according to visitor responses.

Table 6. Visitor preferences for potential expansion or creation actions within Lost Valley.

	Preference points
Create a new campground	24.35
Establish a visitor center	22.20
Expand existing restroom facilities at Lost Valley Trailhead	20.57
Increase size of roadside pullouts for elk viewing	12.64
Create new roadside pullouts for elk viewing	11.82
Establish additional parking options at Lost Valley Trailhead	8.20
TOTAL	100

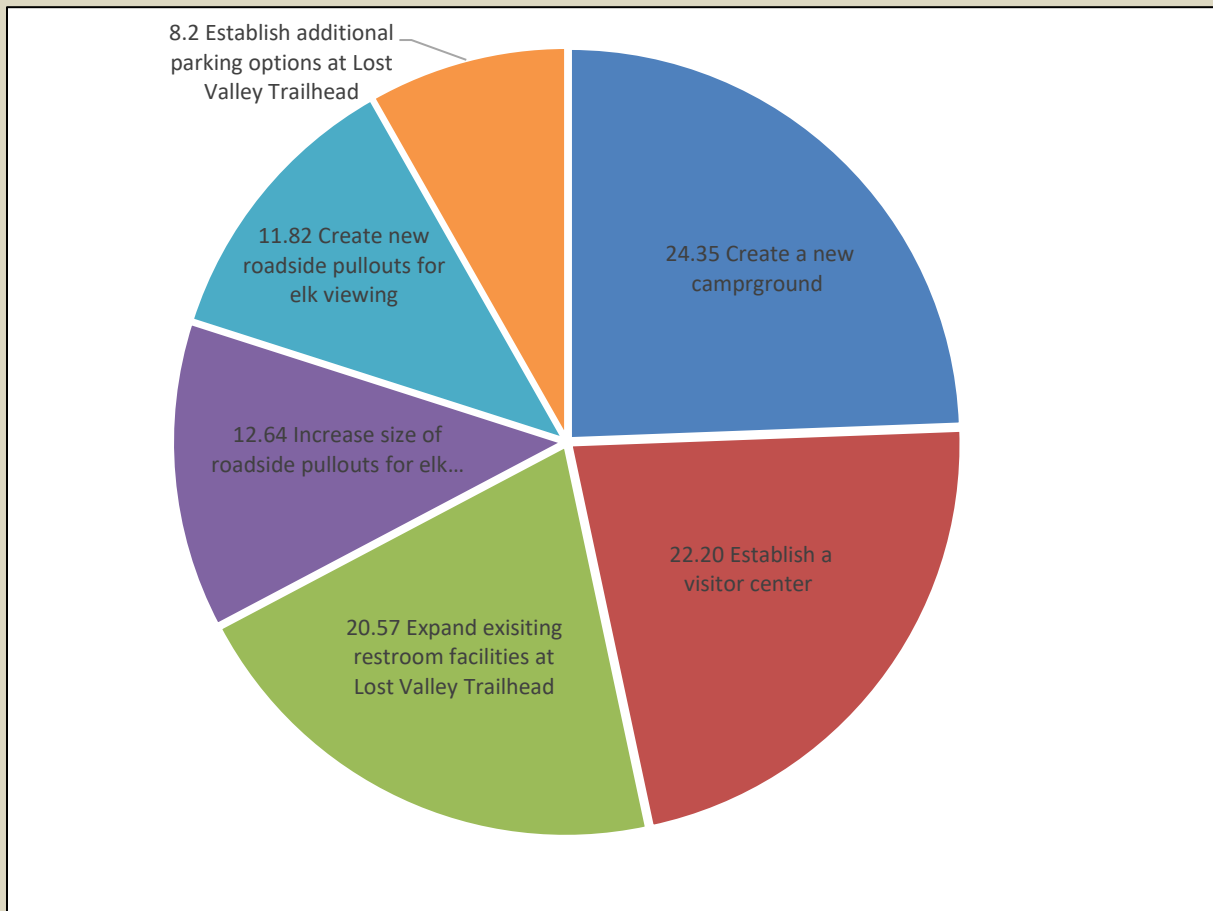


Figure 38. Preference points for potential expansion or creation actions within Lost Valley.

Table 7. Levels of visitor opposition or support for potential expansion or creation actions within Lost Valley.

	Strongly oppose (-3)	Oppose	Somewhat oppose	Neither oppose or support	Somewhat support	Support	Strongly support (+3)	Mean (SD)
Expand existing restroom facilities at Lost Valley Trailhead	0.7	2.2	8.2	16.4	20.9	35.8	15.7	1.25 (1.32)
Establish a visitor center	3.0	4.4	5.2	15.6	19.3	34.8	17.8	1.19 (1.51)
Increase size of roadside pullouts for elk viewing	1.5	2.9	7.3	19.7	24.8	23.4	20.4	1.15 (1.42)
Create a new campground	3.0	3.7	1.5	20.1	27.6	28.4	15.4	1.13 (1.41)
Create new roadside pullouts for elk viewing	2.3	2.3	6.8	25.8	20.5	22.7	19.7	1.07 (1.46)
Establish additional parking options at Lost Valley Trailhead	3.7	6.0	9.7	33.6	18.7	20.1	8.2	0.51 (1.47)

Note. Table ordered by highest mean.

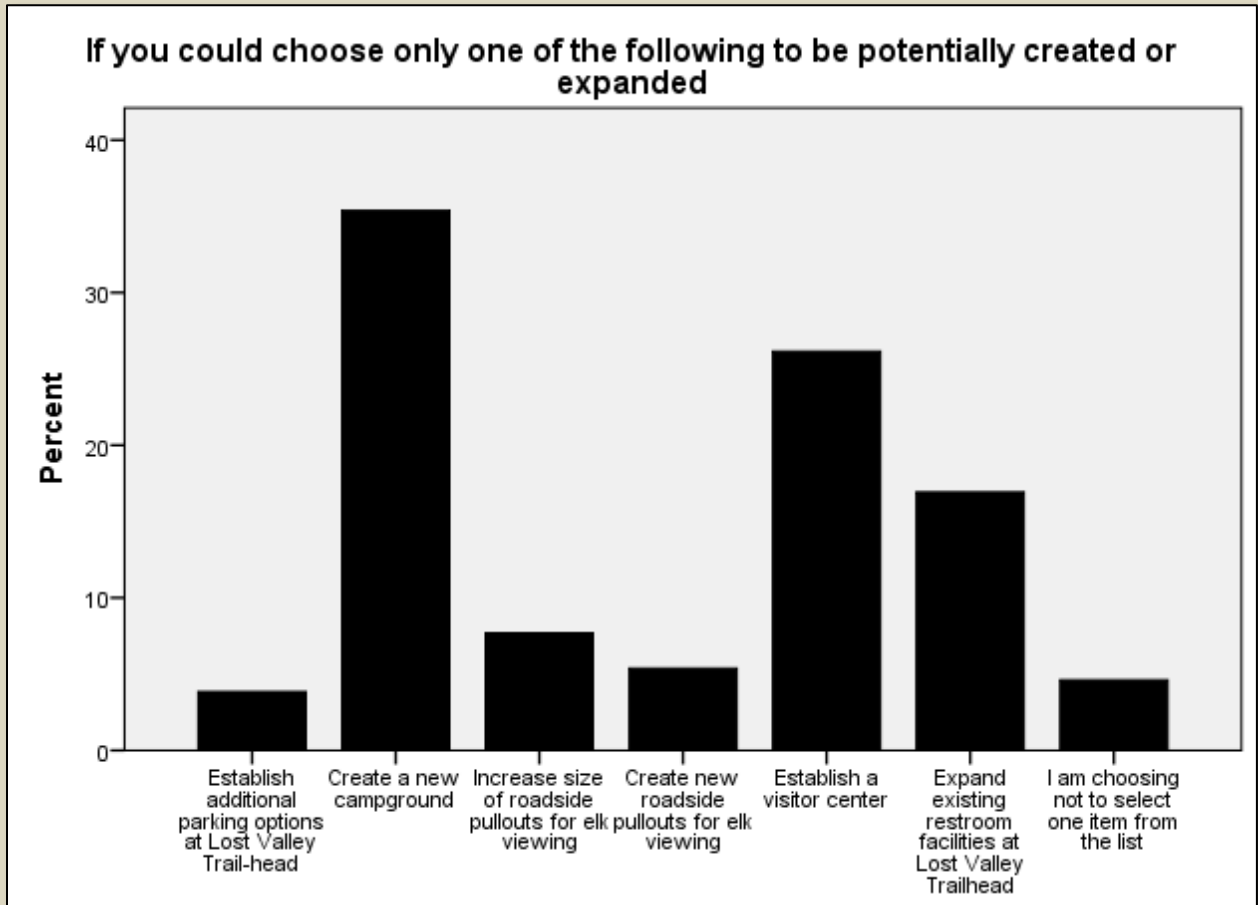


Figure 39. Visitor preferences for the top choice of what potentially should be created or expanded at Lost Valley.

Table 8. Management Action Index for Lost/Boxley Valley.

	Percent of management effort and resources if all actions selected
Create a new campground	31%
Establish a visitor center	24%
Expand existing restroom facilities at Lost Valley Trailhead	18%
Increase size of roadside pullouts for elk viewing	10%
Create new roadside pullouts for elk viewing	9%
Establish additional parking options at Lost Valley Trailhead	8%
TOTAL	100

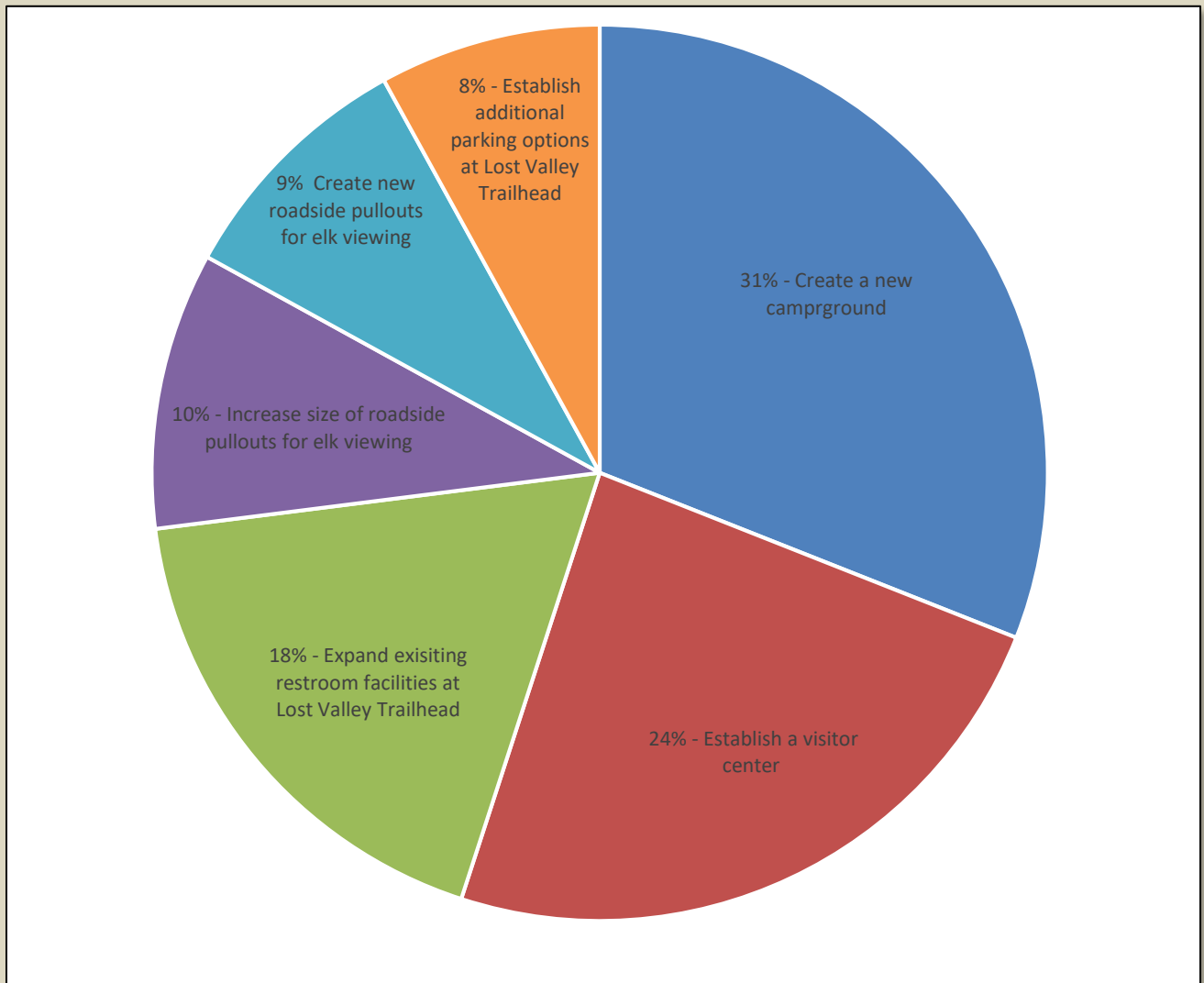


Figure 40. Management Action Index for potential expansion or creation actions within Lost Valley.

Visitors to BUFF generally support the expansion or creation of new facilities in Lost Valley/Boxley Valley area. Overall, four of the six proposed management actions drew support from BUFF visitors. The creation of a new campground had the most support by visitors with 43.8% of visitors “supporting” or “strongly supporting” this management action. The establishment of additional parking and the creation of new pullouts for elk viewing received less support than other management actions.

Visitors at BUFF were asked to allocate 100 “preference points” to six potential management actions at Lost Valley/Boxley Valley. Visitors expressed that the creation of a new campground (24%) was the most popular potential management action. Establishing a visitor center (22%) and expansion of restroom facilities (20%) followed closely behind. These results do not directly reflect the results of the previous question regarding visitor preference to the same potential management actions.

When visitors were faced with only being able to choose one potential management action, over one third of visitors (35%) chose to create a new campground followed by the establishment of a visitor center (26%) and expanding restroom facilities (16%). When faced with the option of not selecting a potential management action, only 5% of visitors chose to not select an item from the list.

Generally, all visitors were either “somewhat satisfied” or “satisfied” with all the current conditions of facilities at BUFF (Table 9). Visitors had the highest level of satisfaction for the cleanliness of the trails ($M = 2.33$, “satisfied”). Visitors had the lowest level satisfaction for the quality of information available about the park ($M = 0.92$, “somewhat satisfied”). *However, it should be strongly noted that even though the quality of information available in the park received the lowest satisfaction score, this question did not produce a mean score that was negative, which would be considered a dissatisfactory score.*

Table 9. Visitor satisfaction of services at Lost Valley.

	Very dissatisfied (-3)	Dissatisfied (-2)	Somewhat dissatisfied (-1)	Somewhat satisfied (+1)	Satisfied (+2)	Very satisfied (+3)	Mean (SD)
Cleanliness of trails	0.0	0.0	0.0	6.9	53.4	39.7	2.33 (0.6)
Cleanliness of picnic areas or other gathering spots	0.0	0.8	1.7	9.3	61.9	26.3	2.08 (0.8)
Cleanliness of parking lots	0.8	0.0	1.6	12.2	57.7	27.6	2.07 (0.87)
Condition of parking lots	0.0	0.0	1.6	17.3	56.7	24.4	2.02 (0.75)
Condition of trails	0.0	0.0	3.9	17.8	47.3	31.0	2.02 (0.92)
Condition of park roads	0.8	0.8	5.9	25.4	45.8	21.2	1.7 (1.13)
Condition of signs	0.0	1.7	9.3	18.6	56.8	13.6	1.6 (1.13)
Cleanliness of restrooms	2.8	1.9	9.3	24.3	34.6	27.1	1.53 (1.47)
Amount of restrooms available	0.0	6.0	19.8	26.7	44.0	3.4	0.93 (1.39)
Quality of information available about the park	2.8	5.7	17.0	27.4	40.6	6.6	0.92 (1.53)
Amount of information available about the park	1.8	7.9	17.5	34.2	31.6	7.0	0.80 (1.51)

Note. Table ordered by highest mean.

Hiking Encounters Per Hour

Visitors intercepted at Eden Falls were asked to assess how many trail encounters with other people are acceptable while recreating at BUFF. Table 10 displays the acceptability of trail encounters with other people. Figure 41 displays the data stratified into three strata: weekdays, weekends, and holidays. Although the following results may transfer easily to other areas in the units and other trails, this transference has not been evaluated.

Table 10. Encounters with other people during a one-hour period on a trail at BUFF.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable (0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
0 people in 1 hour on a trail	1.6	1.0	0.6	1.6	6.8	3.2	3.9	25.9	55.3	2.98 (1.71)
10 people in 1 hour on a trail	0.3	1.0	2.0	3.0	3.9	5.9	8.6	45.1	30.3	2.68 (1.54)
20 people in 1 hour a trail	3.3	4.0	3.7	8.3	7.3	12.6	18.3	32.2	10.3	1.46 (2.10)
30 people in 1 hour on a trail	8.4	7.0	9.1	12.1	11.1	14.8	16.4	15.1	6.0	0.32 (2.35)
40 people in 1 hour on a trail	18.5	9.9	13.6	13.6	11.6	10.9	9.6	8.9	3.3	-0.75 (2.42)
50 people in 1 hour on a trail	26.8	14.9	13.2	14.6	9.2	7.5	6.4	4.4	3.1	-1.47 (2.32)

Note. Table ordered by highest mean.

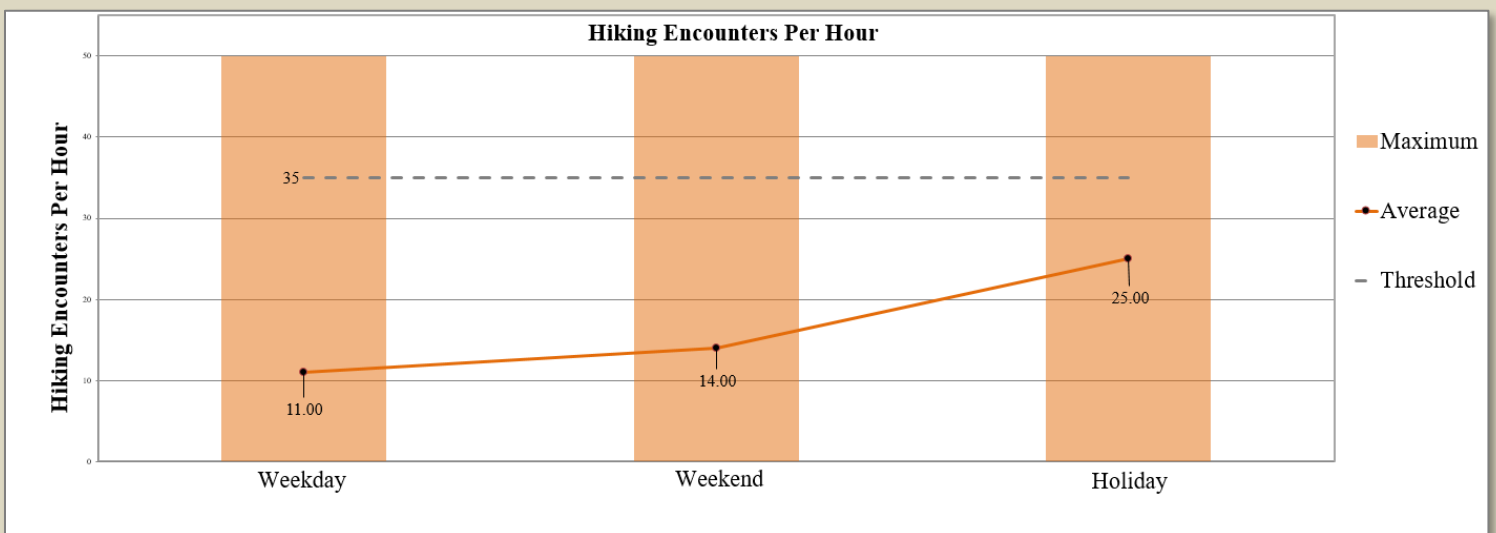


Figure 41. Hiking encounters per hour across three strata: weekdays, weekends, and holidays

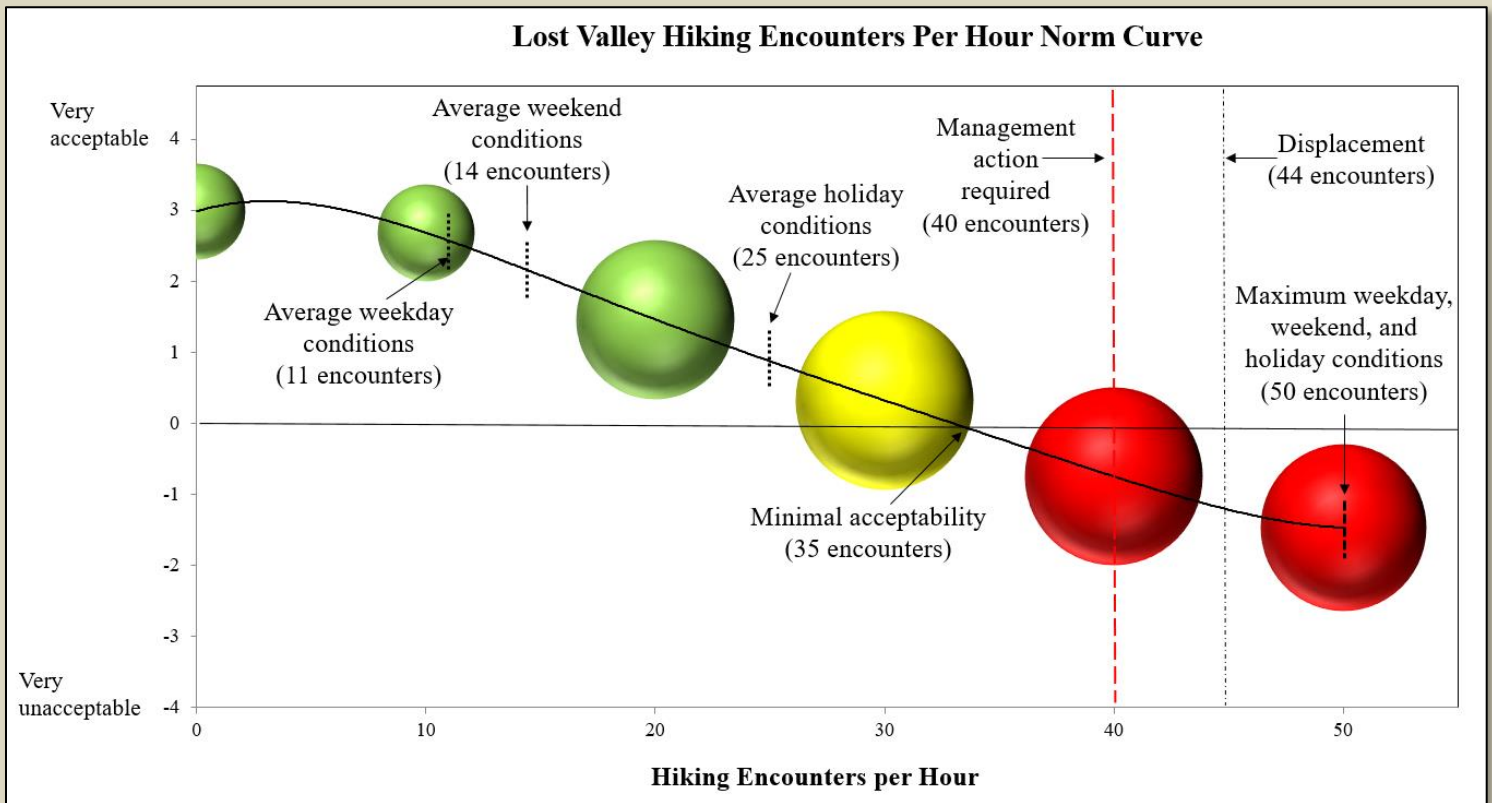


Figure 42. Social norm curve of hiking encounters per hour at Lost Valley. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Informed by management, park documents, and conversations with visitors, the number of people encountered during a one-hour period of hiking was selected as a primary element of the Lost Valley experience that may contribute to the quality of a visit (i.e., indicator of quality). Consequently, the research team evaluated the visitor desired conditions of this “encounter norm” to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against the condition that visitors reported they experienced during their visit in the Eden Falls area.

Overall, the results for hiking encounters display decreasing levels of acceptability as the number of hiking encounters increase (Figure 42). Results indicate that acceptability of conditions decreases by approximately 10% for every increase of 10 people encountered per hour while hiking. On average, visitors report a threshold of 35 people encountered per hour, or restated, when there are more than 35 people encountered per hour while hiking then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 35 people encountered per hour while hiking, with 0 encounters being the most acceptable condition. On average, visitors report that management action is required when 40 people are encountered per hour while hiking and they would not return to BUFF when 44 people are encountered per hour while hiking. Consensus regarding the acceptability rating for people encountered per hour while hiking was moderate (average $PCI^2 = 0.27$), displayed as the size of the bubbles for each variable level on the horizontal axis (x-axis) in Figure

42. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the people encountered per hour while hiking.

On average, visitors report that they encountered 14 people per hour of hiking, which is within the acceptable range for desired conditions. Segmenting the data by type of day (weekend, weekday, or holiday), indicates that *average* weekday (11 encounters), weekend (14 encounters), and holiday (25 encounters) are within the acceptable range (0 to 35 encounters). In other words, the average visitor reported condition for people encountered per hour while hiking does not exceed or violate visitors' threshold for hiking encounters (35 encounters). However, there are periods when the *maximum* encounter reported by visitors exceeded visitors' desired conditions. Specifically, the maximum for hiking encounters per hour was 50 or more for all types of day (weekend, weekday, or holiday). This maximum of 50 or more encounters during one hour of hiking was reported by 1.5% of weekday visitors sampled, 5% of visitors sampled on weekends, and 25% visitors intercepted on holidays. These data suggest that on average the number of people encountered during one hour of hiking is within the acceptable range but there are periods during weekdays, weekends, and holidays where the number of encounters reaches unacceptable levels, particularly on holidays. Furthermore, on holiday weekends, approximately 30% of visitors are reporting encounter conditions that they consider 'requires management action' (action unspecified).

People at One Time at Eden Falls (PAOT)

The questionnaire was used with the pictures in Figure 43 to determine the acceptability for number of people at one time at Eden Falls (PAOT) (Table 11). Three HBC's were deployed at Eden Falls to gather objective data of how many people visited Eden Falls (Figure 44). These two pieces of data were coupled together to construct a social norm curve for PAOT at Eden Falls (Figure 45).

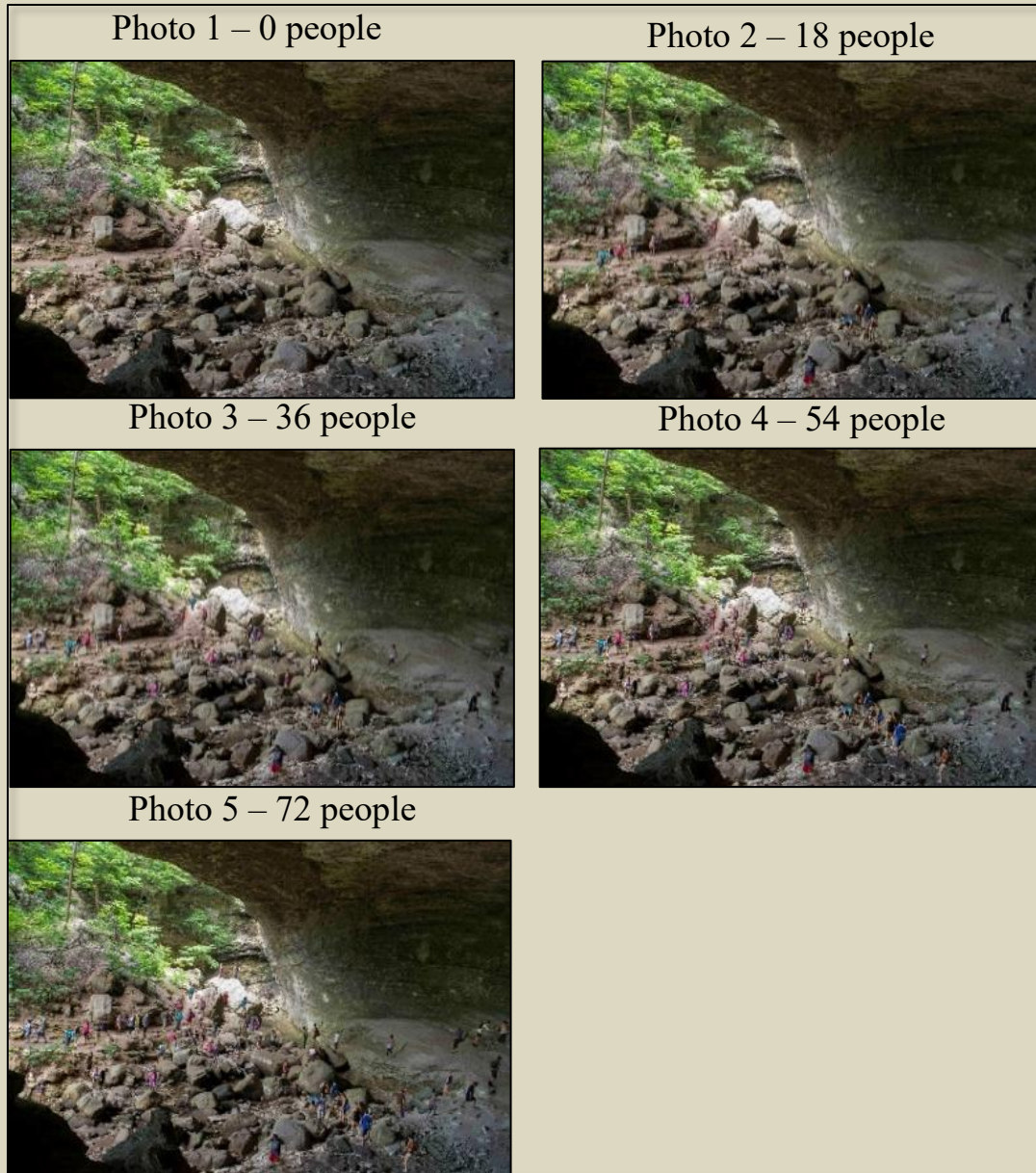


Figure 43. Pictures of Eden Falls with PAOT that corresponds with the social norm curve.

Table 11. Acceptability of People at One Time at Eden Falls (PAOT)

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable(0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
Photo 1 (0 people)	2.3	0.3	1.6	3.6	3.6	3.6	4.9	25.9	54.1	2.90 (1.81)
Photo 2 (18 people)	3.5	4.1	8.3	9.5	7.0	12.7	15.6	24.8	14.6	1.24 (2.27)
Photo 3 (36 people)	6.5	9.7	13.2	18.4	8.1	10.6	11.6	15.2	6.8	0.07 (2.38)
Photo 4 (54 people)	16.0	9.0	14.1	11.9	9.3	9.9	8.0	11.2	10.6	-0.29 (2.67)
Photo 5 (72 people)	24.7	14.8	16.8	10.9	7.2	6.9	4.6	9.9	4.3	-1.55 (2.52)

Note. Table ordered by highest mean.

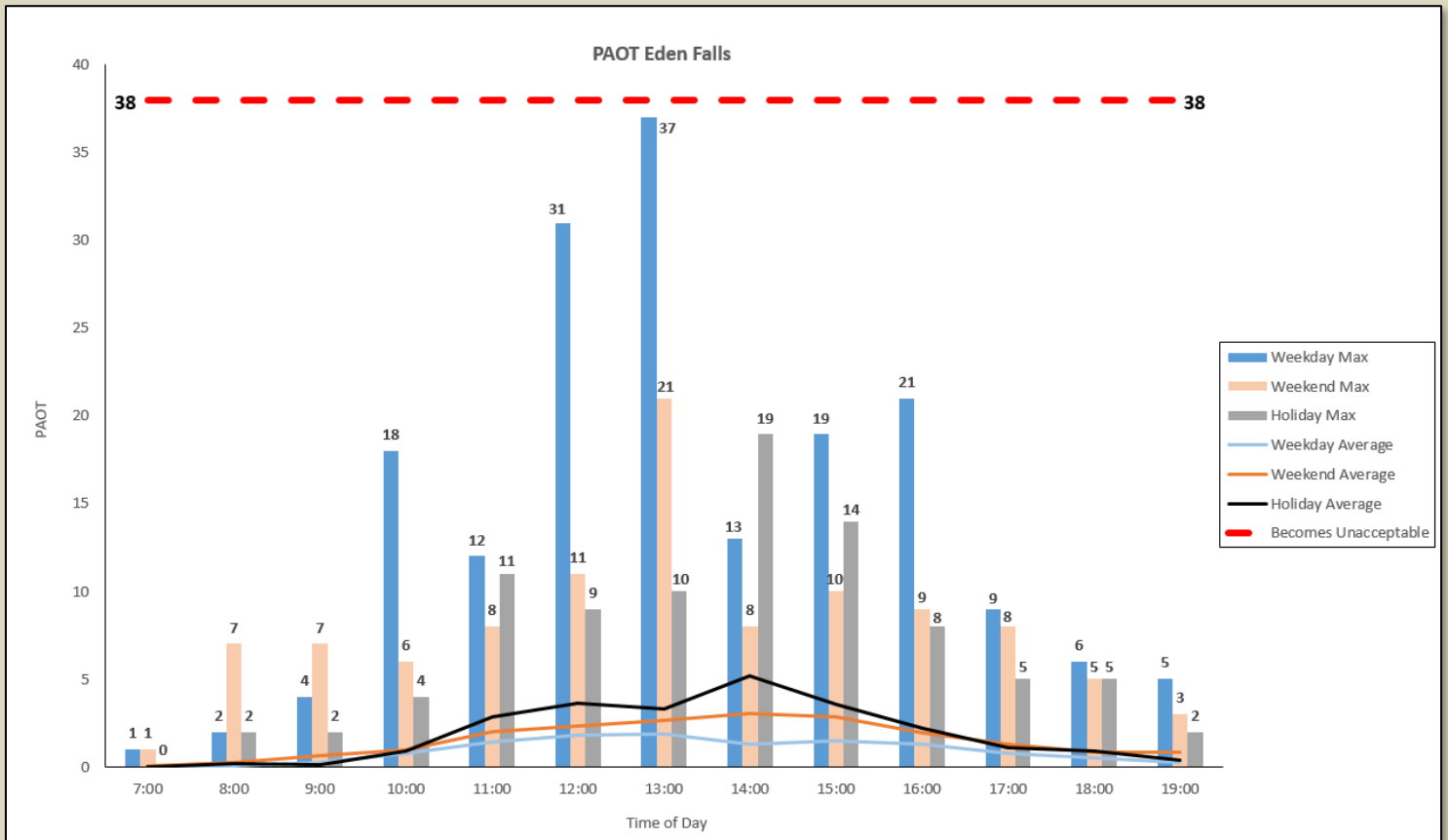


Figure 44. PAOT at Eden Falls determined by Human Behavior Cameras.

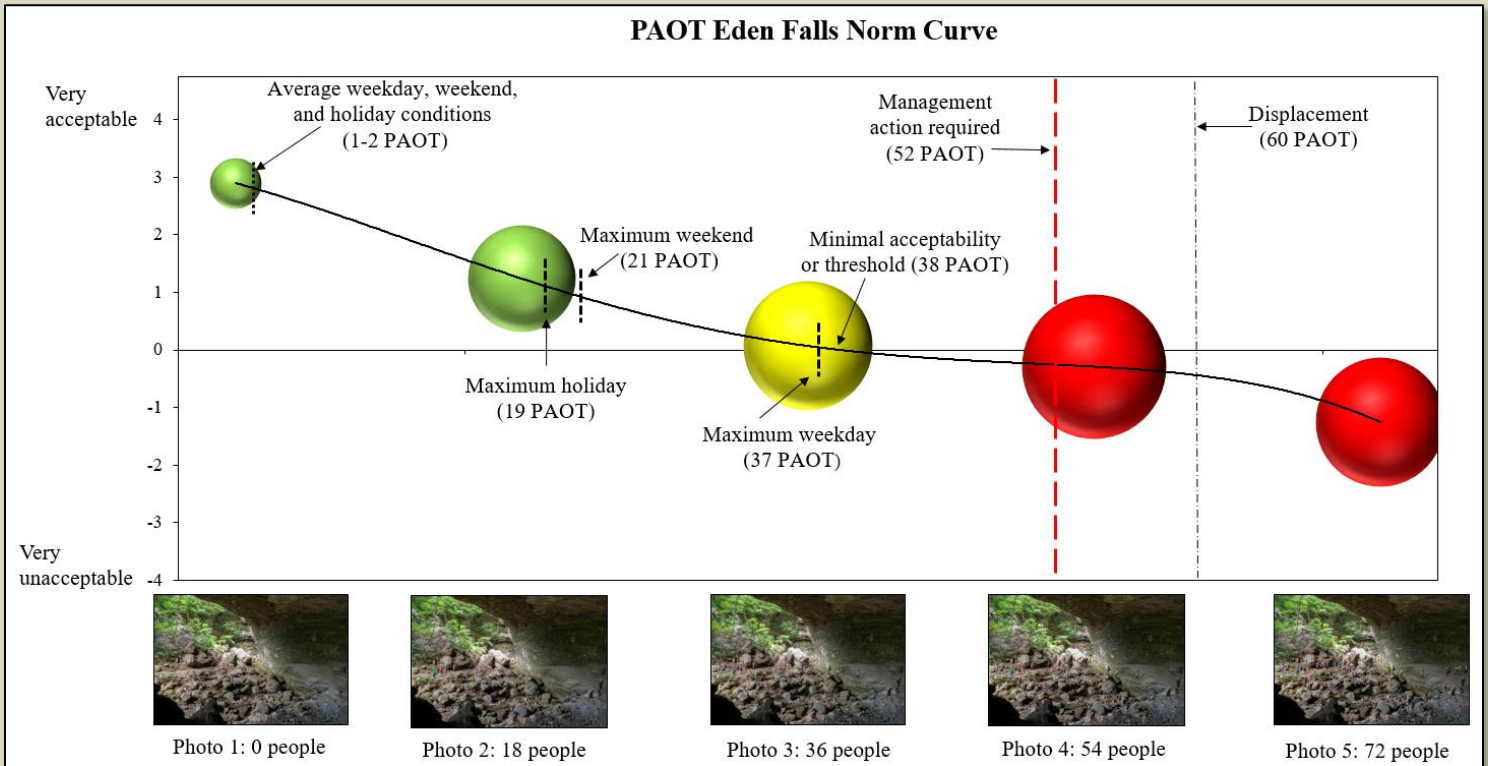


Figure 45. Social norm curve of PAOT at Eden Falls. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Informed by management, park documents, and conversations with visitors, the amount of People at One Time (PAOT) at Eden Falls was selected as a primary element of the Lost Valley experience that may contribute to the quality of a visit (i.e., indicator of quality). Consequently, the research team evaluated the visitor desired conditions of PAOT at Eden Falls to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against actual conditions at Eden Falls recorded by Human Behavior Cameras (HBC) to understand if actual conditions aligned with or exceeded visitors’ desired conditions for the amount of people that can be at Eden Falls at one time.

Overall, the results for People at One Time (PAOT) at Eden Falls display decreasing levels of acceptability as PAOT increases. Results indicate that acceptability of conditions decreases by approximately 10% for every increase of 18 people at Eden Falls. On average, visitors report a threshold of 38 PAOT, or restated, when there are more than 38 people at Eden Falls then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 38 people at Eden Falls, with 0 people being the most acceptable condition. On average, 71% of visitors report that management action is required when 52 people are at Eden Falls (52 PAOT) and 64% of visitors report they would not return to the site when there are 60 people present (60 PAOT). It is important to note that 29% of visitors do not believe that any of the photographs display conditions that require management action and 36% of visitors report that none of the photographs display

conditions so severe that they would be displaced from the site. Furthermore, 21% of visitors reported that use at Eden Falls should never be limited regardless of PAOT, suggesting that a portion of the Eden Falls visiting population is ideologically opposed to use limits. Consensus regarding the acceptability rating for each photograph was moderate (average $PCI^2 = 0.36$), displayed as the size of the bubbles for each photograph on Figure 45. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the conditions displayed in the photographs.

Human Behavior Cameras (HBC) at Eden Falls indicate that *average* weekday (1 PAOT), weekend (2 PAOT), and holiday (2 PAOT) from 7:00 am to 7:00 pm are within the acceptable range (0 to 38 PAOT). Alternatively stated, the average conditions at Eden Falls do not exceed or violate visitors' threshold for the amount of people at one time at Eden Falls (38 PAOT). Between 7:00 am and 7:00 pm, visitors are present at Eden Falls for 31% of the time on weekdays, 54% of the time on weekends, and 58% of the time on holidays. During these times of visitation, the average PAOT was 3 for weekdays, 3 for weekends, and 4 for holidays. These averages do not exceed visitors' minimal acceptable condition of 38 PAOT (Figure 45).

However, there are periods in the year when the *maximum* weekday PAOT recorded by the HBC came close to exceeding visitors' desired conditions. Specifically, maximum PAOT conditions at Eden Falls during one day was 37 PAOT (July) and during another day POAT was 31 (May). Maximum weekend (21 PAOT) and holiday (19 PAOT) conditions recorded by the HBC are within the acceptable range and do not exceed visitors' PAOT threshold (38 PAOT).

The Relationship between People at Eden Falls and Vehicles at the Eden Falls Trailhead Parking Lot

The relationship between People at one Time (PAOT) at Eden Falls and vehicles at one time (VAOT) at the Eden Falls parking lot was statistically significant. Researchers explored regression models using one-half hour time lags representing up to three hours difference between VAOT at the parking lot and PAOT at Eden (seven models total). These one-half hour time lags account for hiking time between the parking lot and the falls. All seven models demonstrate that as vehicles at the parking lot increase, the number of people at Eden Falls increase as well. The two-hour lag produced the best fit, indicating that PAOT at Eden Falls is best predicted by VAOT at the parking lot two hours earlier. For example, the number of vehicles in the parking lot at 9:00 am can predict the conditions at the falls at 11:00 am. However, although significant, the best fitting regression model only accounted for 52% of the variance in PAOT at Eden Falls, leaving 48% of the variance for PAOT at Eden Falls unaccounted for. In other words, the number of vehicles at one time at the parking lot can predict the number of people at Eden Falls two hours later but this prediction occurs with only 52% accuracy.

Therefore, it is unlikely that monitoring and managing conditions at the parking lot only will allow for the effective management of conditions at Eden Falls. This potential lack of monitoring efficacy may be attributed to the complexity of visitation at Eden Falls (by both time and space), which consists of multiple points of interest along the hike (e.g., stream, side trails), a picnic area at the trailhead, and varying lengths of time spent at the falls and on trails accessing the falls.

Boats within View at One Time on the River (BAOT)

Informed by management, park documents, and conversations with visitors, the amount of boats within view at one time while paddling on the river (BAOT) was selected as a primary element of the river experience that may contribute to the quality of a visit (i.e., indicator of quality). Consequently, the research team evaluated the visitor desired conditions of BAOT in the upper and lower river sections to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against visitor reported conditions, or what the conditions that they reported experiencing during their visit. These two pieces of data were used to understand if actual conditions aligned with or exceeded visitors' desired conditions for the amount of boats within view at one time while paddling on the river (Figure 46). BAOT is compared in this section for the Upper Buffalo River (visitors intercepted at Kyle's Landing) and the Lower Buffalo River (visitors intercepted at Dillard's Landing). The results are generally consistent across visitors in these river sections (Table 14).

Overall, the results for boats within view at one time on the river (BAOT) display decreasing levels of acceptability as BAOT increases (Table 12, Table 13). Results indicate that acceptability of conditions decreases by approximately 11% for every increase of 6 boats within view at one time on the river. On average, visitors report a threshold of 13 BAOT, or restated, when there are more than 13 boats within view at one time on the river then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 13 boats within view at one time on the river, with 0 boats being the most acceptable condition. On average, 75% of visitors report that management action is required when 14-15 boats are within view at one time on the river and 65% of visitors report they would not return to the site when there are 16 boats within view at one time on the river. It is important to note that 25% of visitors do not believe that any of the photographs display conditions that require management action and 35% of visitors report that none of the photographs display conditions so severe that they would be displaced from the site. Furthermore, 16% of visitors reported that use on the river should never be limited regardless of BAOT levels, suggesting that a portion of the visiting population is ideologically opposed to use limits. Consensus regarding the acceptability rating for each photograph was moderate (Upper River average $PCI^2 = 0.29$; Lower River average $PCI^2 = 0.32$), displayed as the size of the bubbles for each photograph on Figures 47 and 48. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the conditions displayed in the photographs. Results are generally consistent across visitors intercepted in the lower and upper river sections.

Visitor reported BAOT conditions indicate that *average* weekday (8-10 BAOT) and weekend/holiday (8-11 BAOT) are within the acceptable range (0 to 13 BAOT). However, although these visitor reported conditions are within the acceptable range, they are moderately or minimally acceptable to visitors. This finding suggests that on average BAOT conditions are acceptable but not necessarily preferred. Alternatively stated, the average BAOT conditions on the river do not exceed or violate visitors' threshold for the boats within view at one time on the river (13 BAOT) but are not ideal conditions according to visitors. Of note, there are periods when the *maximum* weekday BAOT reported by visitors far exceeds visitors' desired conditions. Specifically, maximum BAOT conditions are 24 boats within view at one time, which is more than the visitor threshold of 13 BAOT.

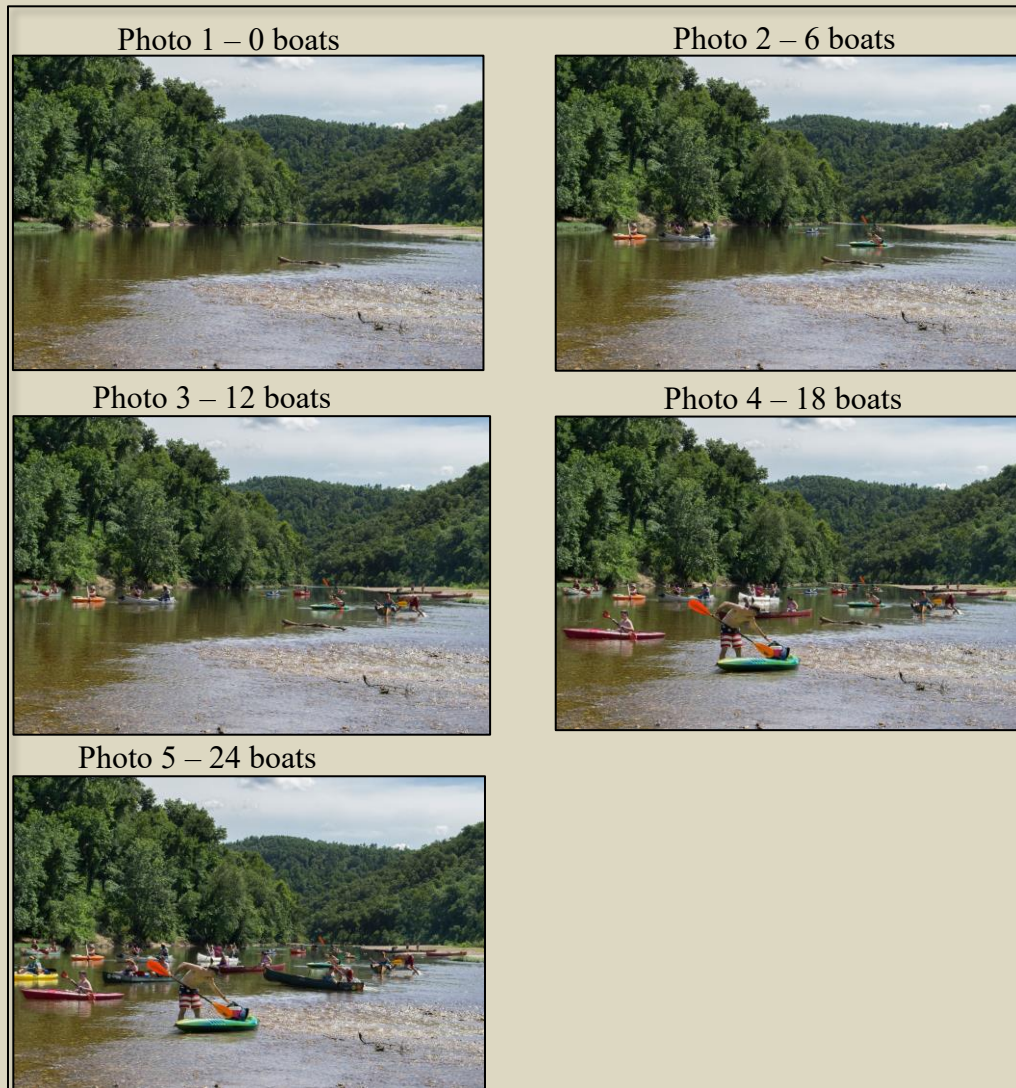


Figure 46. The questionnaires were embedded with these pictures to assess BAOT.

Table 12. Upper River survey results displaying an acceptability matrix for BAOT.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable(0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
Photo 1 (0 boats)	3.5	1.3	0.8	1.5	4.0	3.5	7.0	22.6	55.9	2.88 (1.93)
Photo 2 (6 boats)	1.5	1.8	3.8	6.6	8.1	14.1	18.9	30.1	15.2	1.77 (1.87)
Photo 3 (12 boats)	4.2	8.5	8.2	13.0	10.2	16.2	18.2	15.7	5.7	0.51 (2.21)
Photo 4 (18 boats)	18.6	17.1	17.8	17.1	5.3	8.8	6.0	6.3	3.0	-1.27 (2.28)
Photo 5 (24 boats)	31.1	18.1	13.3	13.0	5.1	3.6	5.1	4.6	6.1	-1.66 (2.48)

Note. Table ordered by highest mean.

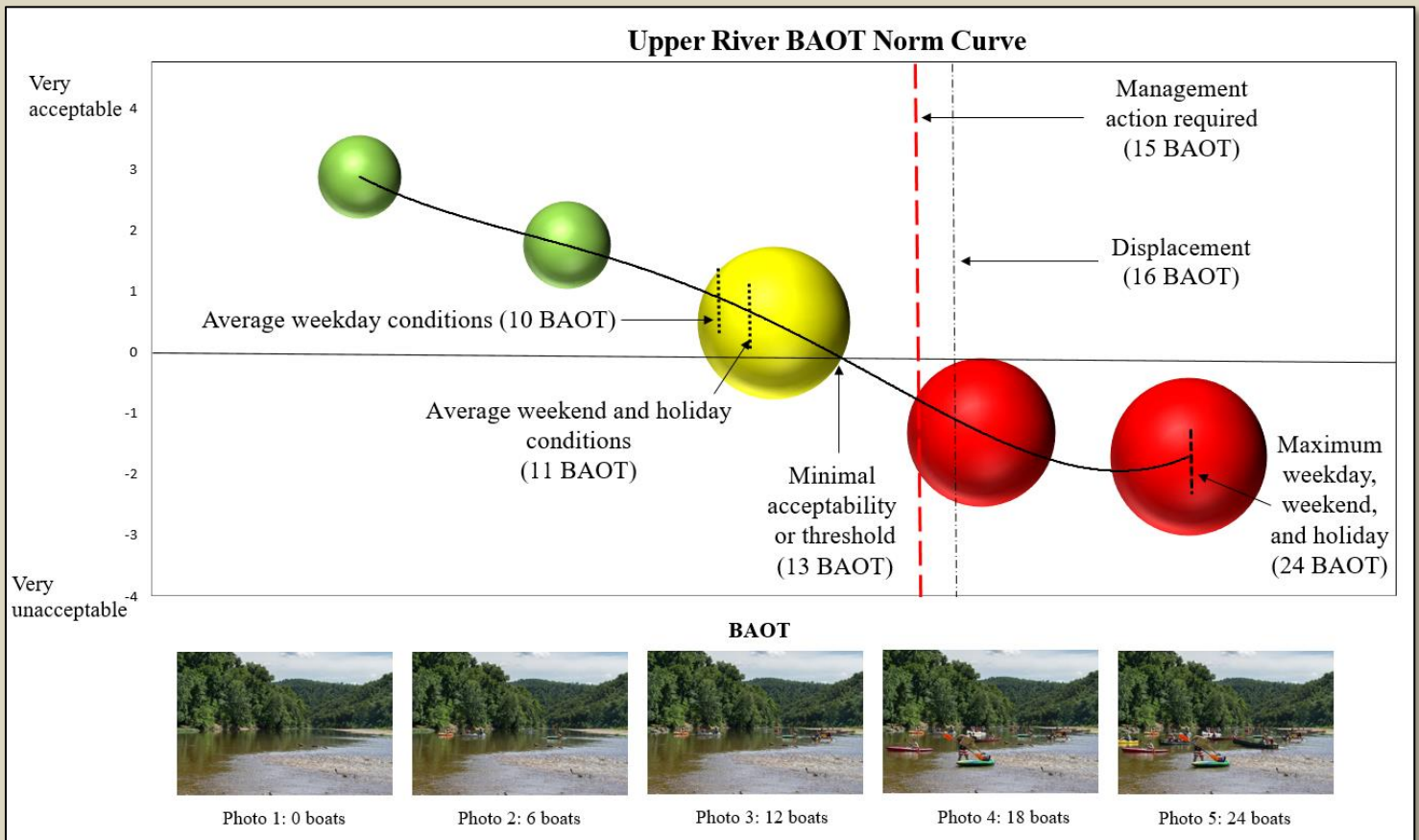


Figure 47. Norm curve of BAOT for the Upper Buffalo River. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 13. Lower River survey results displaying an acceptability matrix for BAOT.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable(0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
Photo 1 (0 boats)	5.6	0.7	1.7	1.3	1.7	1.3	4.3	24.2	59.3	2.90 (2.11)
Photo 2 (6 boats)	2.3	2.0	7.6	6.0	6.3	13.2	15.2	31.8	15.6	1.65 (2.07)
Photo 3 (12 boats)	5.3	6.6	13.2	13.2	9.9	14.1	13.2	17.4	7.2	0.41 (2.31)
Photo 4 (18 boats)	16.6	19.9	19.9	16.2	4.6	6.0	5.3	5.3	6.3	-1.24 (2.37)
Photo 5 (24 boats)	28.5	23.8	17.2	8.3	4.3	4.6	3.6	4.3	5.3	-1.82 (2.37)

Note. Table ordered by highest mean.

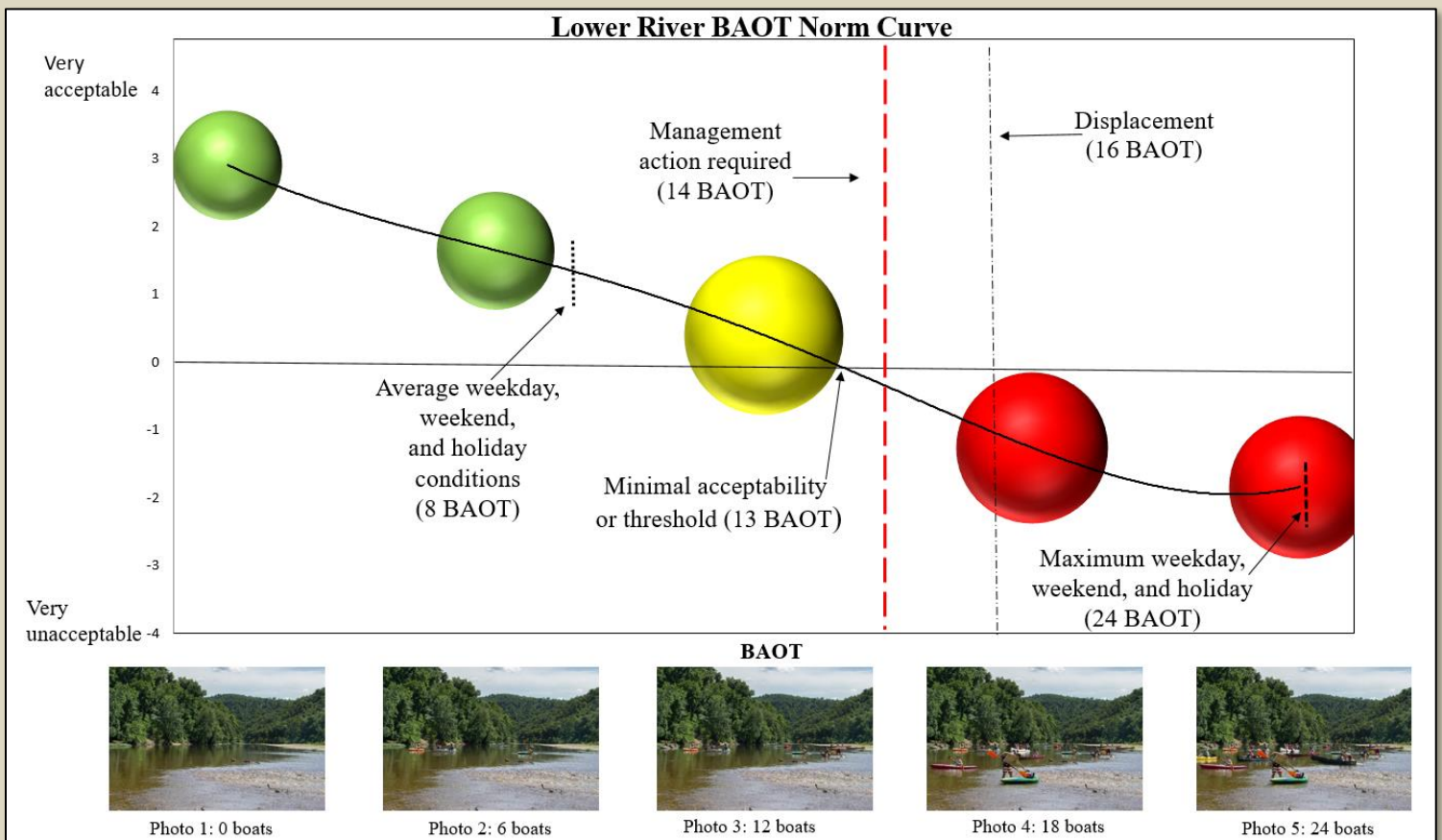


Figure 48. Norm curve of BAOT for the Lower Buffalo River. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 14. *Thresholds and evaluative dimensions for BAOT between the Upper and Lower Buffalo River.*

	Minimal Acceptability Threshold	Management Action Required	Displacement
Upper River	13 BAOT	15 BAOT	16 BAOT
Lower River	13 BAOT	14 BAOT	16 BAOT

River Encounters Per Hour

Informed by management, park documents, and conversations with visitors, the number of encounters with people during a one-hour period was selected as a primary element of the river experience that may contribute to the quality of a visit (i.e., indicator of quality) (referred to here forwards as river encounters). Consequently, the research team evaluated the visitor desired conditions for river encounters in the upper and lower river sections to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against visitor reported conditions, or what the conditions that they reported experiencing during their visit (Table 15, Table 16). These two pieces of data were used to understand if actual conditions aligned with or exceeded visitors' desired conditions for the number of people encountered during a one-hour period. Data for river encounters are compared in this section for the Upper Buffalo River (visitors intercepted at Kyle's Landing) and the Lower Buffalo River (visitors intercepted at Dillard's). The results are generally consistent across visitors in these river sections (Table 17).

Overall, the results for river encounters display decreasing levels of acceptability as encounters increase. Results indicate that acceptability of conditions decreases by approximately 10% for every 20 additional people encountered per hour on the river. On average, visitors report a threshold of 36-39 people encountered per hour, or restated, when there are more than 36-39 people encountered per hour then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 39 people encountered per hour, with 0 encounters being the most acceptable condition. On average, visitors report that management action is required when 70 people are encountered per hour and they would not return to the site when they encounter 81 people per hour. Consensus regarding the acceptability rating for each photograph was moderate (Upper River average $PCI^2 = 0.23$; Lower River average $PCI^2 = 0.30$), displayed as the size of the bubbles for each photograph on Figures 49 and 50. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the conditions displayed in the photographs.

Visitor reported conditions indicate that *average* weekday (21 people encountered on upper river; 16 encountered on lower river) and weekend/holiday (35 people encountered on upper river; 25 encountered on lower river) conditions are within the acceptable range (0 to 39 people encountered per hour). However, although these visitor reported conditions are within the acceptable range, they are moderately or minimally acceptable to visitors. This finding suggests that on average current encounter conditions are acceptable but not necessarily preferred. Alternatively stated, the average encounter conditions on the river do not exceed or violate visitors' threshold (39 people encountered per hour) but are not ideal conditions according to visitors. Of note, there are periods when the *maximum* weekday conditions for encounters reported in the upper river (60 people encountered per hour) exceeds visitors'

desired conditions. However, maximum weekday encounters in the lower river (20 people) appear to be below visitor thresholds.

Table 15. Upper River survey results displaying an acceptability matrix for people seen in an hour on the river.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable (0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
0 people in 1 hour on a river	1.5	2.3	2.1	2.6	8.7	3.9	6.2	31.9	40.9	2.56 (1.93)
20 people in 1 hour on a river	2.3	4.4	7.4	8.2	11.3	14.9	14.9	27.9	8.7	1.18 (2.10)
40 people in 1 hour a river	7.5	15.3	13.5	15.0	11.4	13.5	11.4	9.6	2.8	-0.41 (2.24)
60 people in 1 hour on a river	21.5	21.2	15.8	17.6	7.0	6.2	4.9	3.9	1.8	-1.64 (2.09)
80 people in 1 hour on a river	32.6	27.5	16.1	9.1	4.7	3.9	3.1	2.1	1.3	-2.31 (1.90)
100 people in 1 hour on a river	48.0	23.6	8.3	7.5	4.0	3.8	2.1	1.6	1.1	-2.70 (1.84)

Note. Table ordered by highest mean.

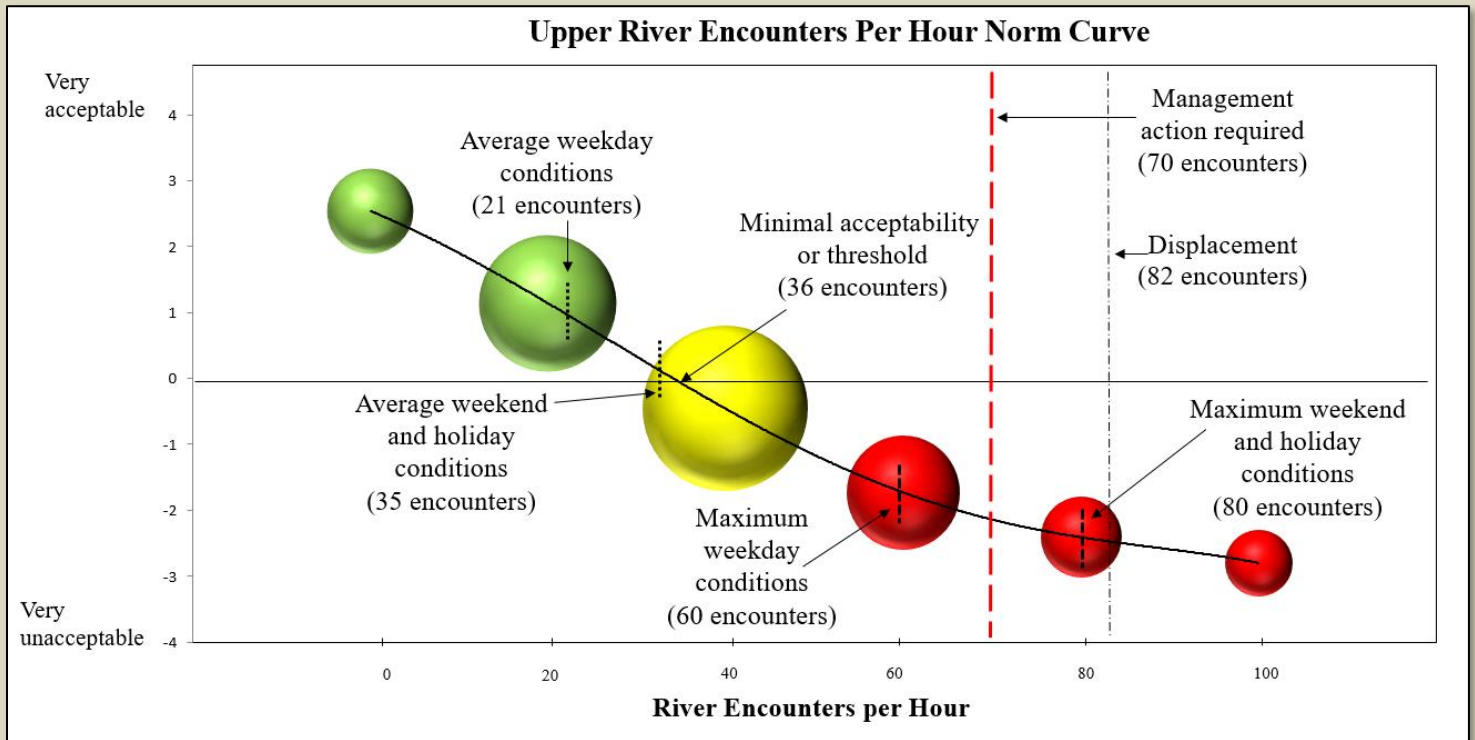


Figure 49. Norm curve displaying encounters per hour conditions for the Upper River. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 16. Lower River survey results displaying an acceptability matrix for people seen in an hour on the river.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable(0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
0 people in 1 hour on a river	4.1	2.7	3.1	2.7	6.8	1.4	3.4	31.3	44.6	2.47 (2.25)
20 people in 1 hour on a river	3.2	6.3	6.7	8.8	6.0	11.3	18.0	30.6	9.2	1.22 (2.24)
40 people in 1 hour a river	10.5	11.2	10.5	18.0	10.2	12.2	9.5	13.9	3.7	-0.27 (2.37)
60 people in 1 hour on a river	23.0	16.7	13.9	14.3	8.7	8.4	6.3	6.6	2.1	-1.35 (2.31)
80 people in 1 hour on a river	32.6	25.4	12.3	11.6	4.3	6.5	2.9	3.3	1.1	-2.16 (2.02)
100 people in 1 hour on a river	45.7	24.3	10.1	4.9	4.1	5.2	1.9	3.0	0.7	-2.60 (1.93)

Note. Table ordered by highest mean.

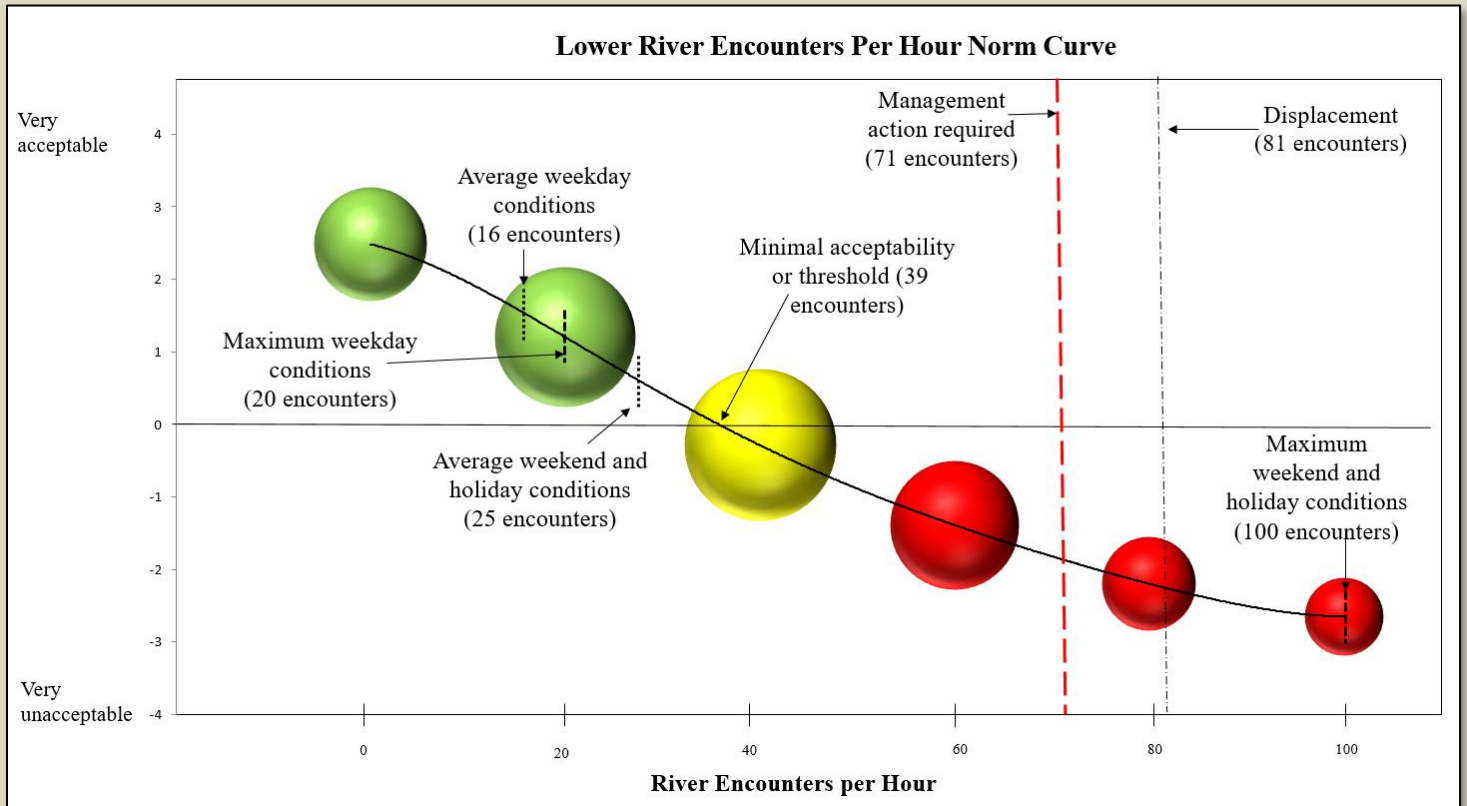


Figure 50. Norm curve displaying encounters per hour conditions for the Lower River. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 17. Summation table of visitor-reported encounters per hour along the Upper and Lower Buffalo River

	Minimal Acceptability Threshold	Management Action	Displacement
Upper River	36 encounters	70 encounters	82 encounters
Lower River	39 encounters	71 encounters	81 encounters

People at One Time at River Access Areas (PAOT)

Ponca PAOT

Informed by management, park documents, and conversations with visitors, the amount of People at One Time at River Access Areas (PAOT) was selected as a primary element of the BUFF experience that may contribute to the quality of a visit (i.e., indicator of quality). PAOT was evaluated for conditions at Ponca Access, Kyle's Landing, Hasty Access, and Dillard's Ferry. This current section focuses results on visitor preferences and conditions at Ponca Access area (referred here forward as POAT-Ponca). As described earlier in this report, the research team paid special attention to depict crowding and congestion at Ponca, which involved using people, boats, and vehicles in most photographs (Figure 51). The research team opted to include all of these elements in the photographs to more accurately align study photographs with actual conditions at study focus areas, as opposed to displaying photographs with only people, or only boats. In this case, people are the primary proxy for crowding and watercraft are assumed to generally accompany people.

The research team evaluated the visitor desired conditions of PAOT at Ponca to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against actual conditions at Ponca recorded by Human Behavior Cameras (HBC) to understand if actual conditions aligned with or exceeded visitors' desired conditions for the amount of people that can be at Ponca at one time (Figure 52).

Overall, the results for PAOT-Ponca display decreasing levels of acceptability as PAOT increases (Table 18). Results indicate that acceptability of conditions decreases by approximately 10% for every increase of 8 people at Ponca. On average, visitors report a threshold of 20 PAOT, or restated, when there are more than 20 people at Ponca then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 20 people at Ponca, with 0 people being the most acceptable condition. On average, 85% of visitors report that management action is required when 21 people are at Ponca (21 PAOT) and 74% of visitors report they would not return to the site when there are 22 people present (22 PAOT). It is important to note that 15% of visitors do not believe that any of the photographs display conditions that require management action and 26% of visitors report that none of the photographs display conditions so severe that they would be displaced from the site. Furthermore, 13% of visitors reported that use at Ponca should never be limited regardless of PAOT, suggesting that a portion of the Ponca visiting population is ideologically opposed to use limits. Consensus regarding the acceptability rating for each photograph was moderate (average $PCI^2 = 0.39$), displayed as the size of the bubbles for each photograph on Figure 53. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the conditions displayed in the photographs.

Human Behavior Cameras (HBC) at Ponca indicate that average weekday (1 PAOT), weekend (3 PAOT), and holiday (4 PAOT) from 7:00 am to 7:00 pm are within the acceptable range (0 to 20 PAOT). Alternatively stated, the average conditions at Ponca do not exceed or violate visitors' threshold for the amount of people at one time. However, there are periods in the year when the maximum weekday PAOT recorded by the HBC exceeded visitors' desired conditions. Specifically, maximum weekday PAOT conditions at Ponca during one day was 70 PAOT (10/5/16) (Table 19, Figure 54). Maximum weekend conditions recorded by the HBC were minimally acceptable (20 PAOT recorded on 4/8/17).



Figure 51. Photos used to assess PAOT at Ponca.

Table 18. Ponca acceptability matrix for visitor-reported acceptability of people at one time.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable(0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
Photo 1 (0 people)	9.6	5.1	2.5	2.5	3.6	2.5	2.5	11.7	59.9	2.21 (2.84)
Photo 2 (8 people)	7.7	2.6	5.1	0.5	8.2	9.2	17.4	34.4	14.9	1.57 (2.34)
Photo 3 (16 people)	4.0	3.5	6.5	12.9	12.4	17.4	13.9	18.9	10.4	0.92 (2.15)
Photo 4 (24 people)	13.4	12.4	13.4	17.9	10.9	9.0	8.5	11.4	3.0	-0.64 (2.35)
Photo 5 (32 people)	32.2	16.6	10.6	6.5	7.0	5.5	3.0	8.5	10.1	-1.29 (2.84)

Note. Table ordered by highest mean.

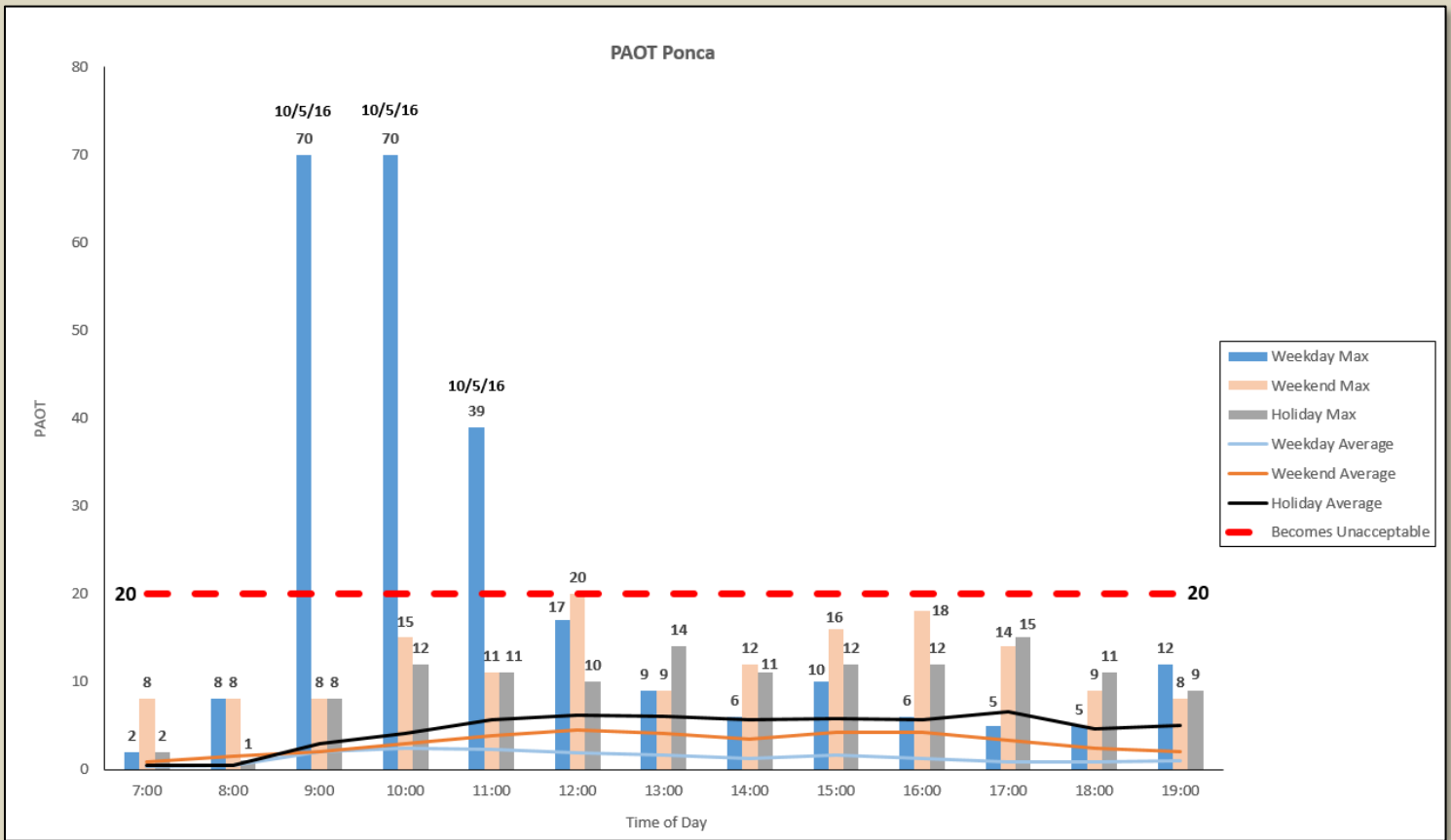


Figure 52. PAOT Ponca HBC data.

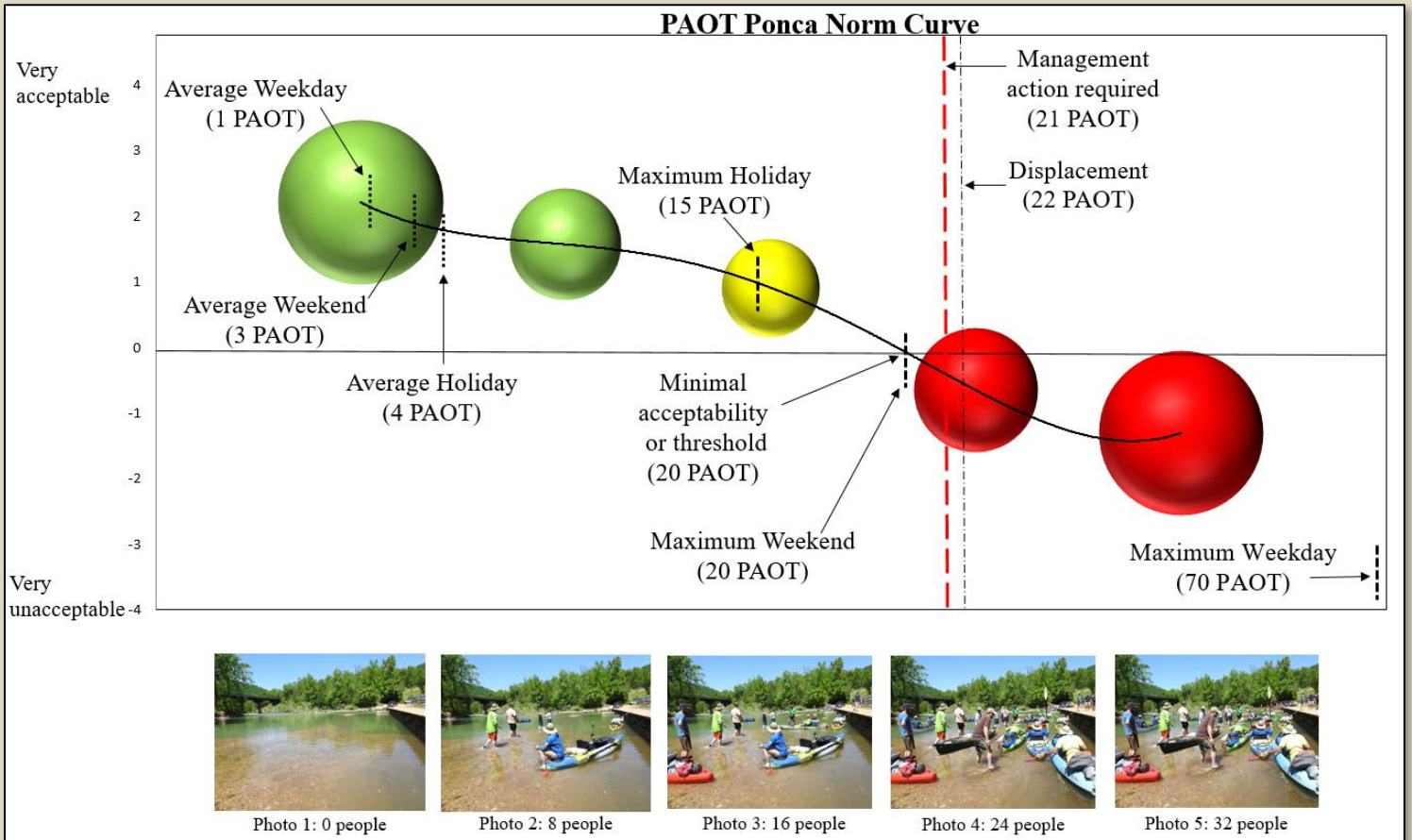


Figure 53. PAOT Ponca norm curve. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 19. PAOT seasonal maximums and averages at Ponca.

Season	Max PAOT	Date & Time of Max PAOT	Average per hour
Spring	20	4/8/17 12:30	2.51
Summer	18	8/27/16 15:53	2.30
Fall	70	10/5/16 10:07	3.17
Winter	15	2/19/17 17:30	1.38

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

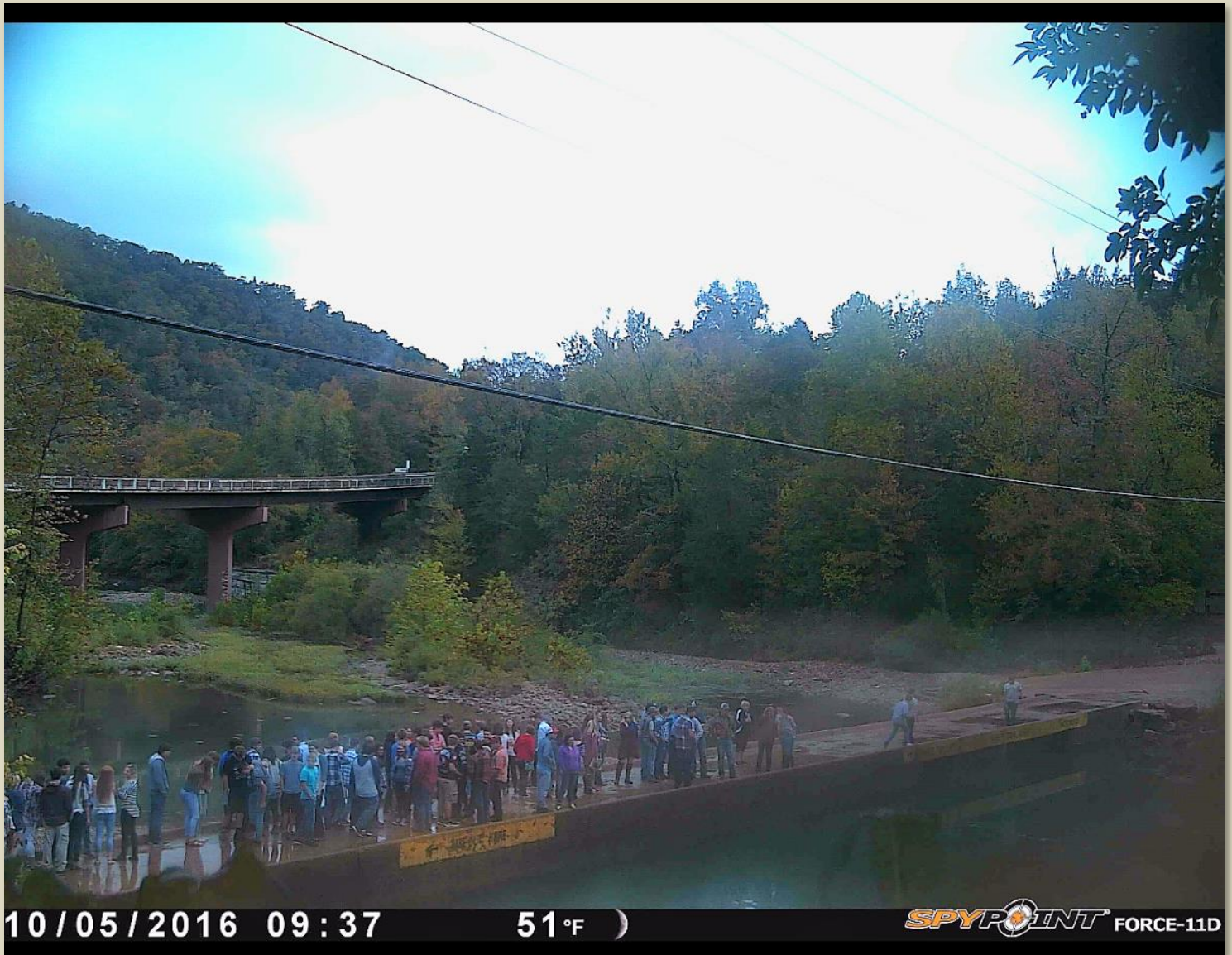


Figure 54. Example of PAOT threshold violation at Ponca.

Kyle's Landing PAOT

Informed by management, park documents, and conversations with visitors, the amount of People at One Time at River Access Areas (PAOT) was selected as a primary element of the BUFF experience that may contribute to the quality of a visit (i.e., indicator of quality). PAOT was evaluated for conditions at Ponca Access, Kyle's Landing, Hasty Access, and Dillard's Ferry. This current section focuses results on visitor preferences and conditions at Kyle's Landing (referred here forward as POAT-Kyle's). As described earlier in this report, the research team paid special attention to depict crowding and congestion at Kyles, which involved using people and boats in most photographs (Figure 55). The research team opted to include all of these elements in the photographs to more accurately align study photographs with actual conditions at study focus areas, as opposed to displaying photographs with only

people, or only boats. In this case, people are the primary proxy for crowding and watercraft are assumed to generally accompany people.

The research team evaluated the visitor desired conditions of PAOT at Kyle's to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against actual conditions at Kyle's recorded by Human Behavior Cameras (HBC) to understand if actual conditions aligned with or exceeded visitors' desired conditions for the amount of people that can be at Kyle's at one time (Figure 56).

Overall, the results for PAOT-Kyle's display decreasing levels of acceptability as PAOT increases. Results indicate that acceptability of conditions decreases by approximately 10% for every increase of 9 people at Kyle's (Table 20). On average, visitors report a threshold of 23 PAOT, or restated, when there are more than 23 people at Kyle's then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 23 people at Kyle's, with 0 people being the most acceptable condition. On average, 76% of visitors report that management action is required when 20 people are at Kyle's (20 PAOT) and 63% of visitors report they would not return to the site when there are 22 people present (22 PAOT). It is important to note that 24% of visitors do not believe that any of the photographs display conditions that require management action and 37% of visitors report that none of the photographs display conditions so severe that they would be displaced from the site. Furthermore, 16% of visitors reported that use at Kyle's should never be limited regardless of PAOT, suggesting that a portion of the visiting population is ideologically opposed to use limits. Consensus regarding the acceptability rating for each photograph was moderate (average $PCI^2 = 0.28$), displayed as the size of the bubbles for each photograph on Figure 57. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the conditions displayed in the photographs.

Human Behavior Cameras (HBC) at Kyle's Landing indicate that average weekday (1 PAOT), weekend (2 PAOT), and holiday (1 PAOT) from 7:00 am to 7:00 pm are within the acceptable range (0 to 23 PAOT). Alternatively stated, the average conditions at Kyle's do not exceed or violate visitors' threshold for the amount of people at one time. There was only one occasion at Kyle's Landing in which actual conditions exceeded visitors' desired conditions. Specifically, the HBC recorded maximum PAOT conditions at Kyle's (28 PAOT) to have exceeded visitors' desired conditions on 4/1/17 at 6:00pm (Table 21).

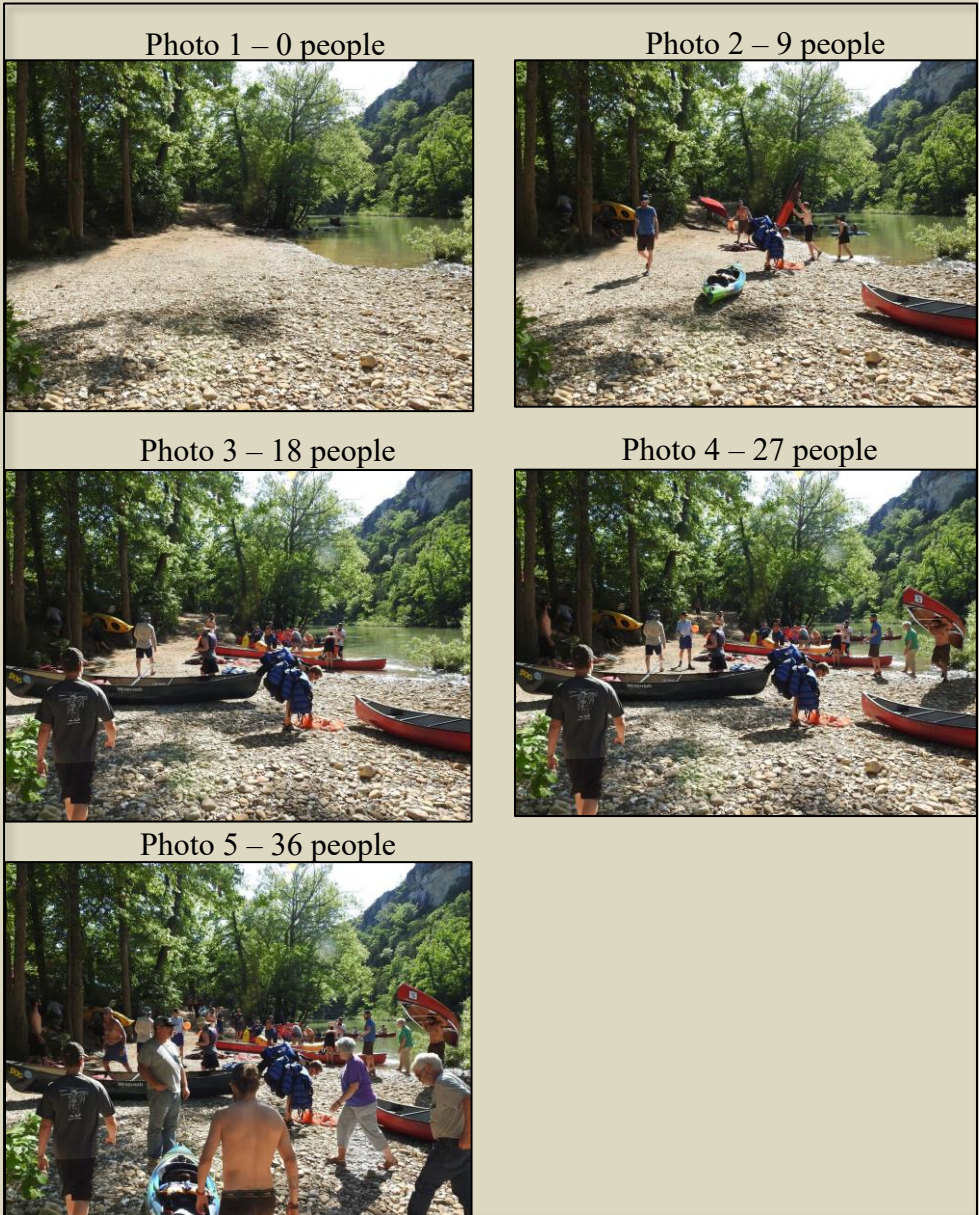


Figure 55. Kyle’s Landing photos used to inform the acceptability matrix seen in Table 25.

Table 20. Kyle's Landing acceptability matrix for visitor-reported acceptability of people at one time.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable(0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
Photo 1 (0 people)	3.2	2.7	1.6	1.1	4.8	3.2	1.6	19.7	62.2	2.89 (2.07)
Photo 2 (9 people)	2.1	1.1	1.6	4.2	6.3	10.0	14.2	43.2	17.4	2.18 (1.77)
Photo 3 (18 people)	3.6	2.1	7.8	15.0	13.0	14.0	15.5	25.4	3.6	0.84 (2.04)
Photo 4 (27 people)	6.7	13.0	18.1	20.7	10.4	8.8	8.3	10.4	3.6	-0.52 (2.21)
Photo 5 (36 people)	26.4	21.5	19.7	11.4	3.1	5.7	4.7	5.7	2.1	-1.80 (2.22)

Note. Table ordered by highest mean.

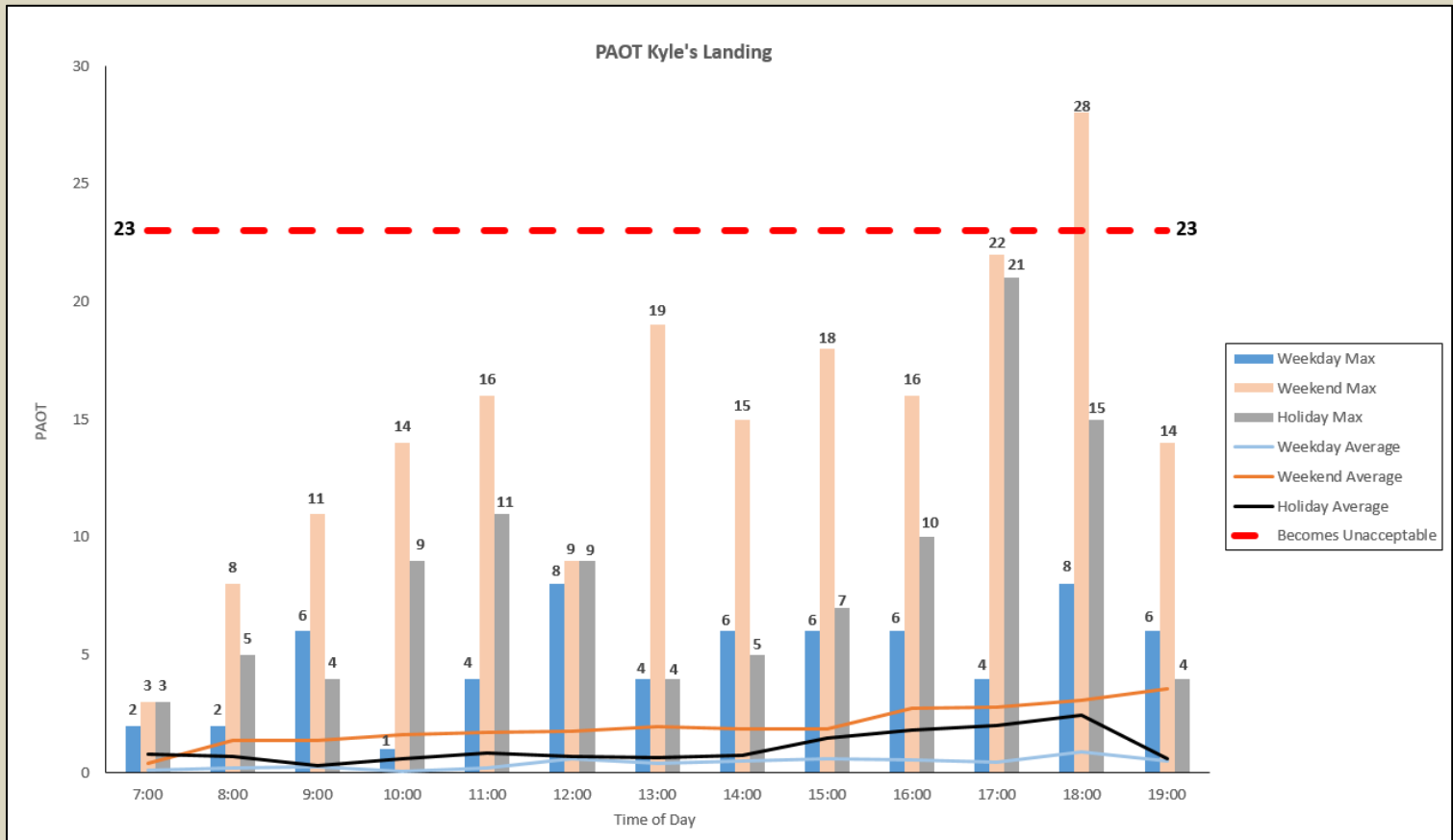


Figure 56. PAOT Kyle's Landing HBC data.

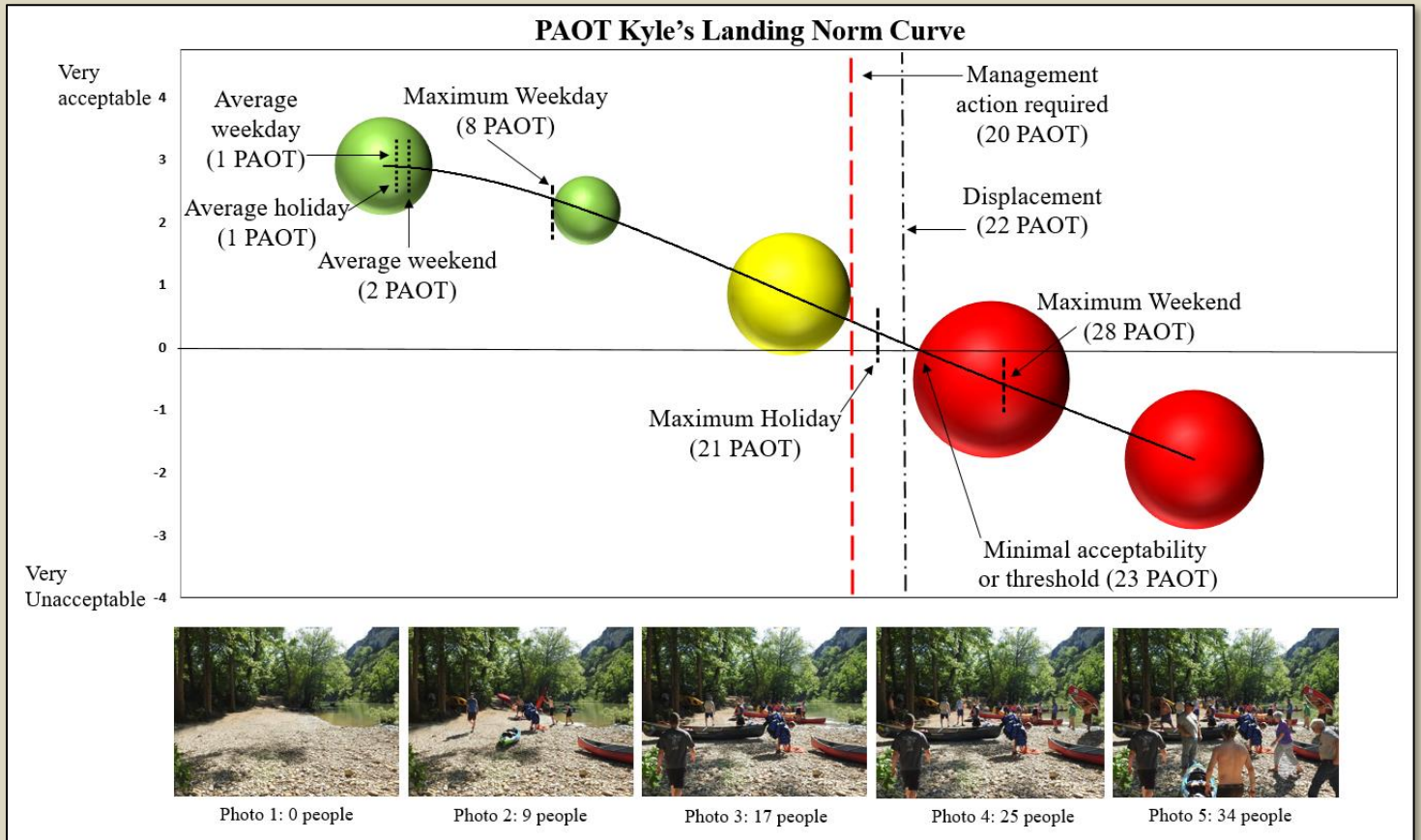


Figure 57. Kyle's Landing PAOT norm curve. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 21. PAOT seasonal maximums and averages at Kyle's Landing.

Season	Max PAOT per Hour	Date & Time of Max PAOT	Average per Hour
Spring	28	4/1/17 18:00	3.76
Summer	15	7/4/17 18:00	1.55
Fall	21	9/4/16 18:21	0.91
Winter	9	2/18/17 10:45	0.30

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Hasty PAOT

Informed by management, park documents, and conversations with visitors, the amount of People at One Time at River Access Areas (PAOT) was selected as a primary element of the BUFF experience that may contribute to the quality of a visit (i.e., indicator of quality). PAOT was evaluated for conditions at Ponca Access, Kyle’s Landing, Hasty Access, and Dillard’s Ferry. This current section focuses results on visitor preferences and conditions at Hasty Access (referred here forward as POAT-Hasty). Researchers did not intercept visitors at Hasty to complete a questionnaire. However, we did monitor the conditions in 2016-17 at Hasty using Human Behavior Cameras (HBCs) (Figure 58). The visitor preference and desired conditions data from visitor intercepts at Kyle’s were used to judge against the monitored conditions at Hasty (Figure 59).

Human Behavior Cameras (HBC) at Hasty indicate that average weekday (1 PAOT), weekend (2 PAOT), and holiday (2 PAOT) from 7:00 am to 7:00 pm are within the acceptable range (0 to 23 PAOT). Alternatively stated, the average conditions at Hasty do not exceed or violate visitors’ threshold for the amount of people at one time. There are several times in the year when the maximum PAOT count on a weekday, holiday, or weekend recorded by the HBC exceeded visitors’ desired conditions (Table 22, Figure 60, Figure 61). Specifically, maximum PAOT conditions at Hasty during one weekday was 74 (6/22/17), which far exceeds the threshold of 23 PAOT. Further, there was one weekend day recorded with 48 PAOT (6/24/17), and one holiday weekend day recorded with 27 PAOT (7/2/17). These recordings exceed the minimal acceptable condition (i.e., threshold) of 23 PAOT.

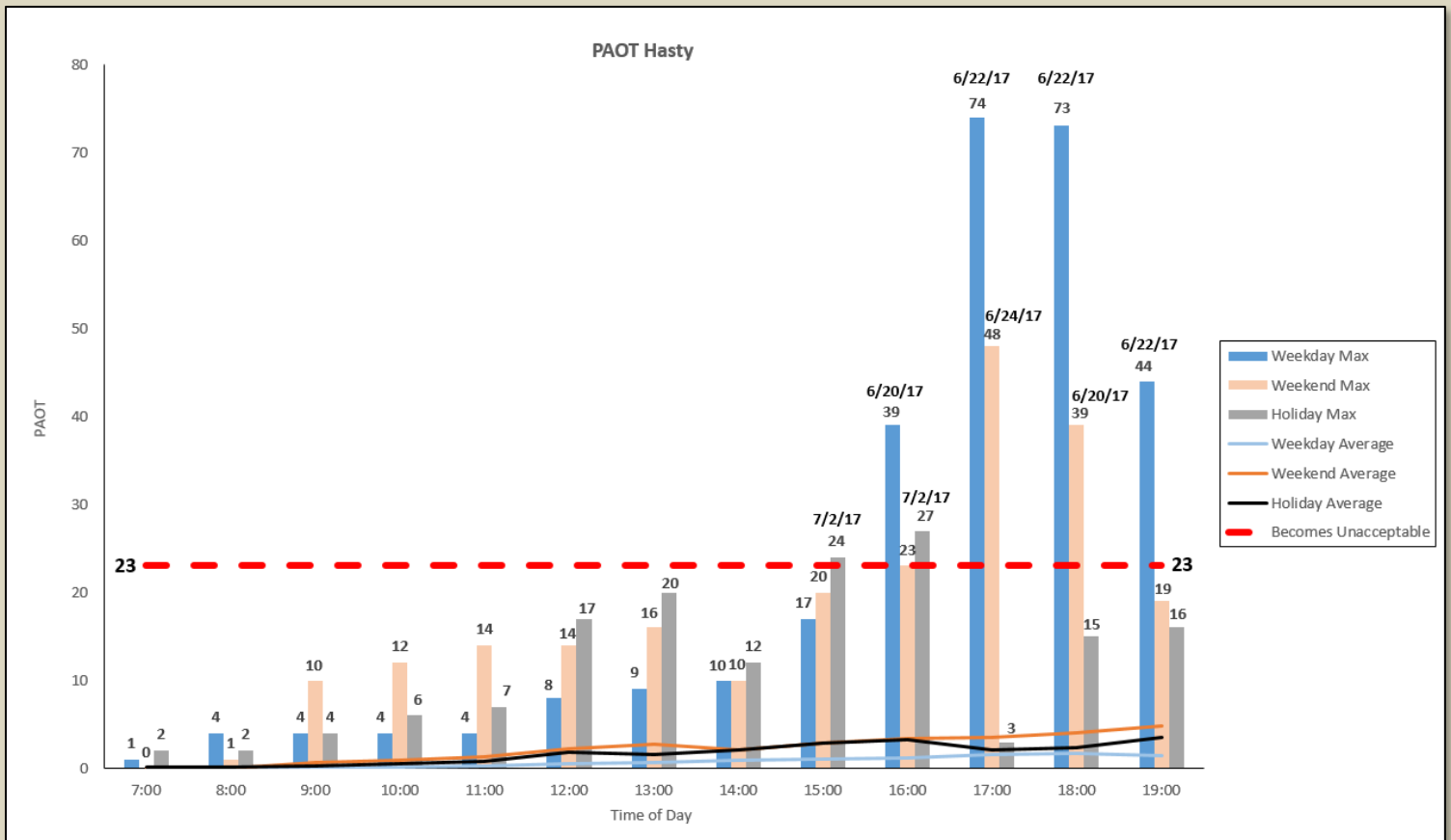


Figure 58. PAOT Hasty HBC data.

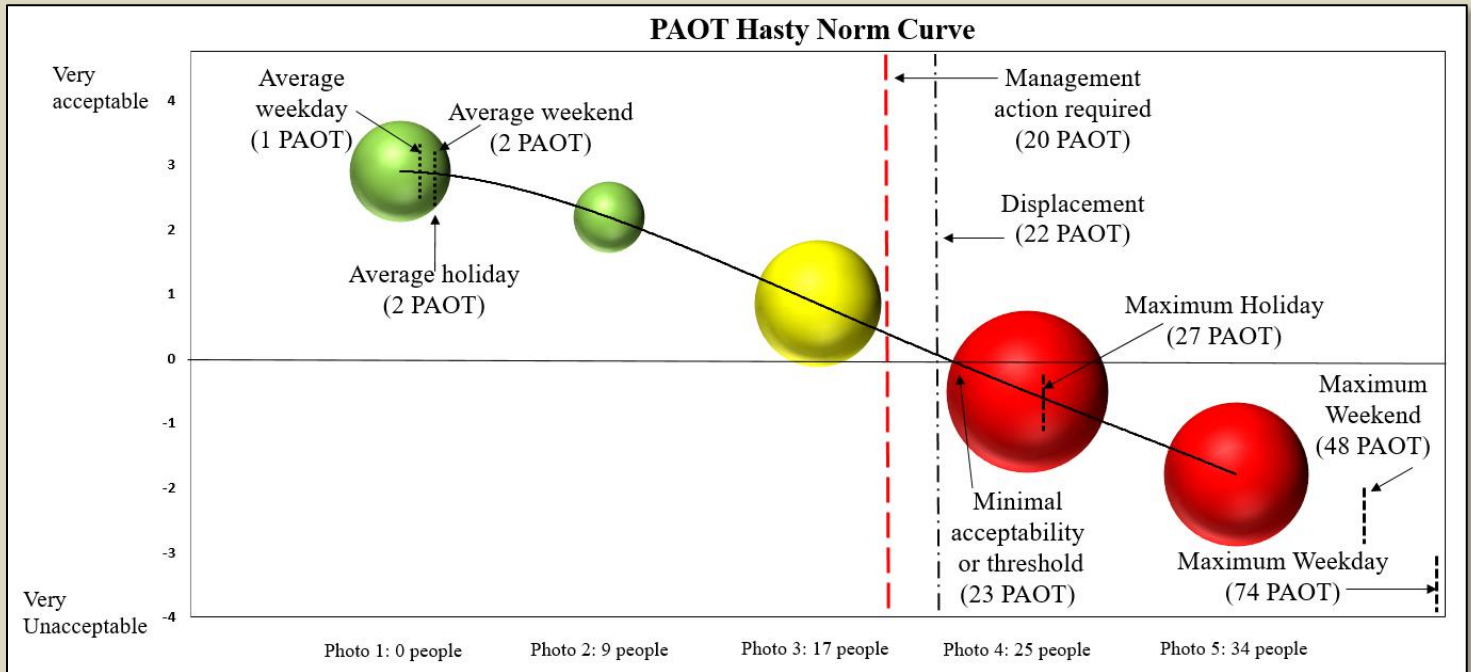


Figure 59. Hasty PAOT norm curve. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 22. PAOT seasonal maximums and averages at Hasty.

Season	Max PAOT per Hour	Date & Time of Max PAOT	Average per Hour
Spring	20	4/15/17 15:15	1.10
Summer	74	6/22/17 17:15	3.67
Fall	12	9/4/16 15:23	0.44
Winter	9	12/17/16 12:37	0.19

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.



Figure 60. Example of PAOT threshold violation at Hasty.



Figure 61. Example of PAOT threshold violation at Hasty.

Dillard's PAOT

Informed by management, park documents, and conversations with visitors, the amount of People at One Time at River Access Areas (PAOT) was selected as a primary element of the BUFF experience that may contribute to the quality of a visit (i.e., indicator of quality). PAOT was evaluated for conditions at Ponca Access, Kyle's Landing, Hasty Access, and Dillard's Ferry. This current section focuses results on visitor preferences and conditions at Dillard's Ferry (referred here forward as POAT-Dillard's). As described earlier in this report, the research team paid special attention to depict crowding and congestion at Dillard, which involved using people, vehicles, and boats in most photographs (Figure 62). The research team opted to include all of these elements in the photographs to more accurately align

study photographs with actual conditions at study focus areas, as opposed to displaying photographs with only people, or only boats. In this case, people are the primary proxy for crowding and watercraft and vehicles are assumed to generally accompany people.

The research team evaluated the visitor desired conditions of PAOT at Dillard's Ferry to understand the conditions that visitors deem a) the minimal acceptable condition (i.e., threshold), b) when management action should take place (i.e., management action), and c) when they might not return to the site because of conditions (i.e., displacement). These desired conditions, or visitor norms, were judged against actual conditions at Dillard's recorded by Human Behavior Cameras (HBC) to understand if actual conditions aligned with or exceeded visitors' desired conditions for the amount of people that can be at Dillard's at one time (Figure 63).

Overall, the results for PAOT-Dillard's indicate decreasing levels of acceptability as PAOT increases (Table 23). Results indicate that acceptability of conditions decreases by approximately 10% for every increase of 20 people at Dillard's. On average, visitors report a threshold of 50 PAOT, or restated, when there are more than 50 people at Dillard's then conditions become unacceptable to visitors. This finding also suggests that the range of acceptable conditions occurs between 0 to 50 people at Dillard's, with 0 people as being the most acceptable condition.

On average, 86% of visitors report that management action is required when 49 people are at Dillard's (49 PAOT) and 78% of visitors report they would not return to the site when there are 54 people present (54 PAOT). It is important to note that 14% of visitors do not believe that any of the photographs display conditions that require management action and 22% of visitors report that none of the photographs display conditions so severe that they would be displaced from the site. Furthermore, 18% of visitors reported that use at Dillard's Ferry should never be limited regardless of PAOT, suggesting that a portion of the visiting population is ideologically opposed to use limits. Consensus regarding the acceptability rating for each photograph was moderate (average $PCI^2 = 0.30$), displayed as the size of the bubbles for each photograph on Figure 64. This level of consensus indicates that on average visitors tend to agree on the acceptability rating regarding the conditions displayed in the photographs.

Human Behavior Cameras (HBC) at Dillard's Ferry indicate that average weekday (1 PAOT), weekend (5 PAOT), and holiday (5 PAOT) from 7:00 am to 7:00 pm are within the acceptable range (0 to 50 PAOT). Alternatively stated, the average conditions at Dillard's Ferry do not exceed or violate visitors' threshold for the amount of people at one time. There were no recorded times in the year when the maximum count on a weekday, holiday, or weekend PAOT recorded by the HBC exceeded visitors' desired conditions. However, on 6/17/17 a maximum number of 50 PAOT was recorded at Dillard's Ferry, which is the minimal acceptable condition reported by visitors (Table 24).

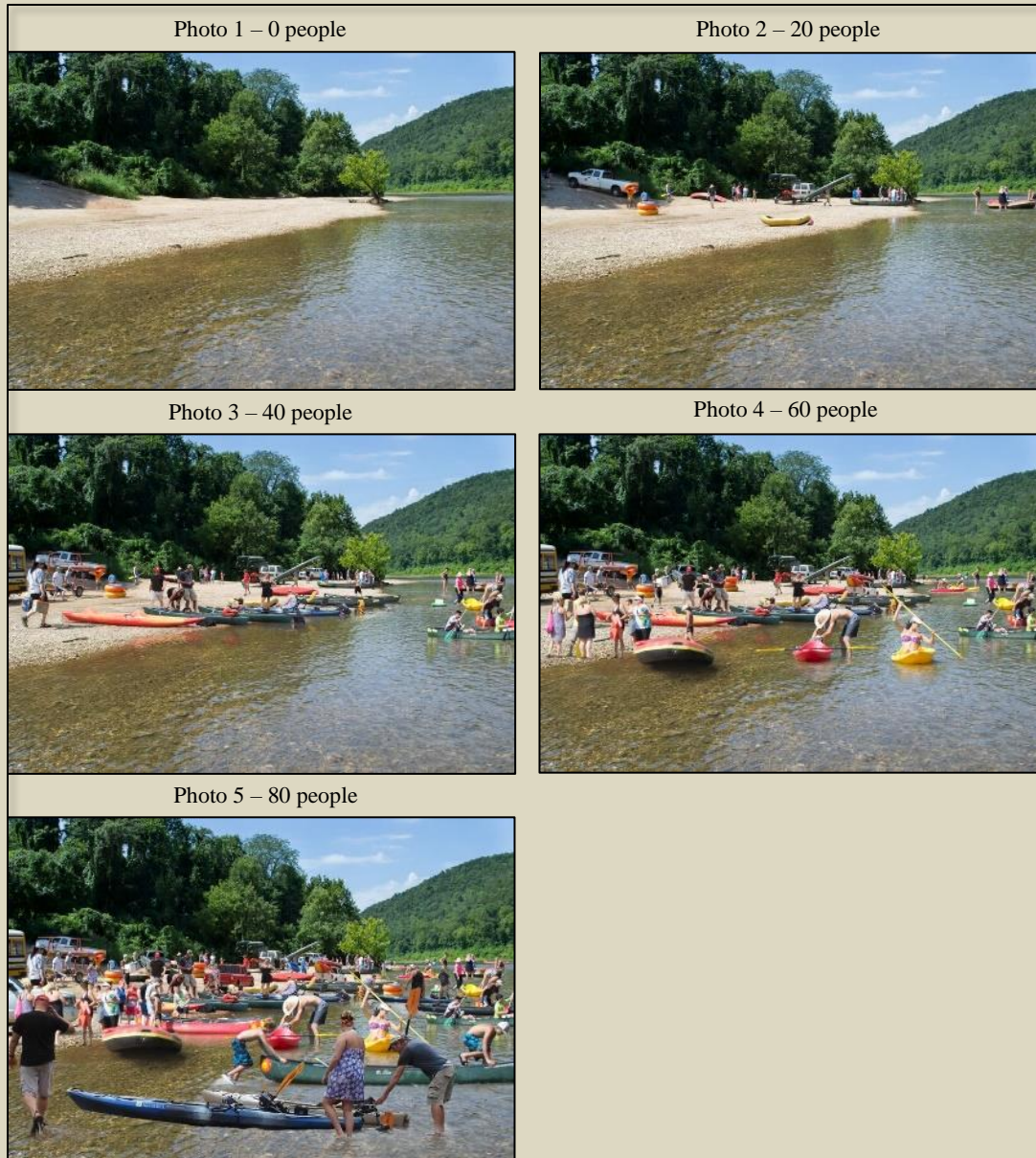


Figure 62. Photos of PAOT at Dillard's that were used to inform the acceptability matrix in Table 23.

Table 23. Dillard's acceptability matrix for people at one time.

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately Unacceptable (-2)	Slightly Unacceptable (-1)	Neither acceptable or unacceptable (0)	Slightly Acceptable (+1)	Moderately Acceptable (+2)	Acceptable (+3)	Very Acceptable (+4)	Mean (SD)
Photo 1 (0 people)	5.2	1.9	2.2	1.9	1.9	1.1	2.6	14.2	68.9	2.92 (2.25)
Photo 2 (20 people)	0.7	0.7	1.1	2.6	3.7	5.6	16.0	36.1	33.5	2.70 (1.52)
Photo 3 (40 people)	6.3	5.9	7.4	13.0	8.9	16.7	13.0	21.9	7.0	0.66 (2.31)
Photo 4 (60 people)	15.4	16.9	19.5	10.1	9.0	9.7	9.0	7.5	3.0	-0.99 (2.35)
Photo 5 (80 people)	49.1	11.7	9.8	10.2	1.9	4.5	4.2	4.9	3.8	-2.18 (2.43)

Note. Table ordered by highest mean.

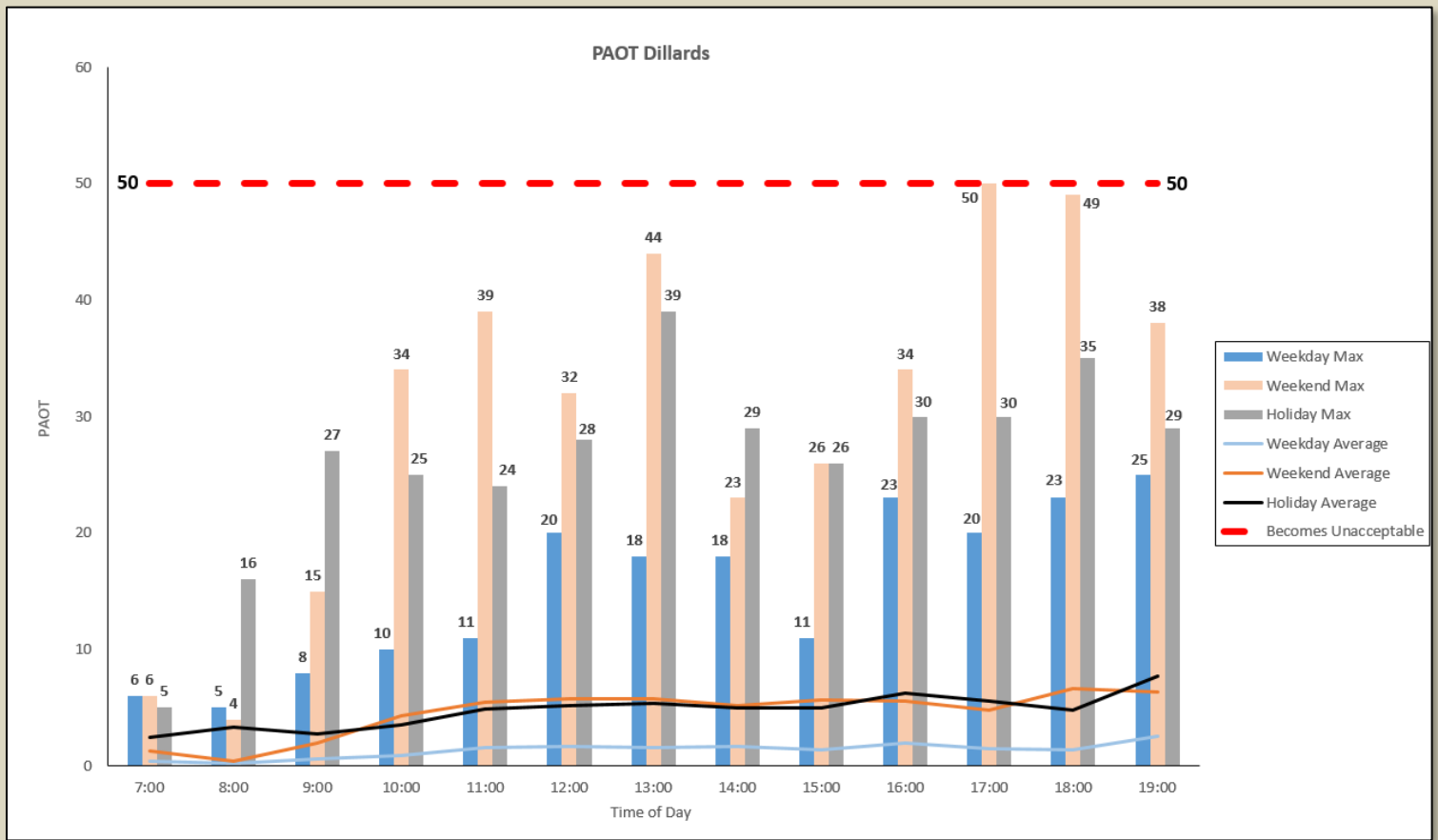


Figure 63. PAOT Dillard's HBC data.

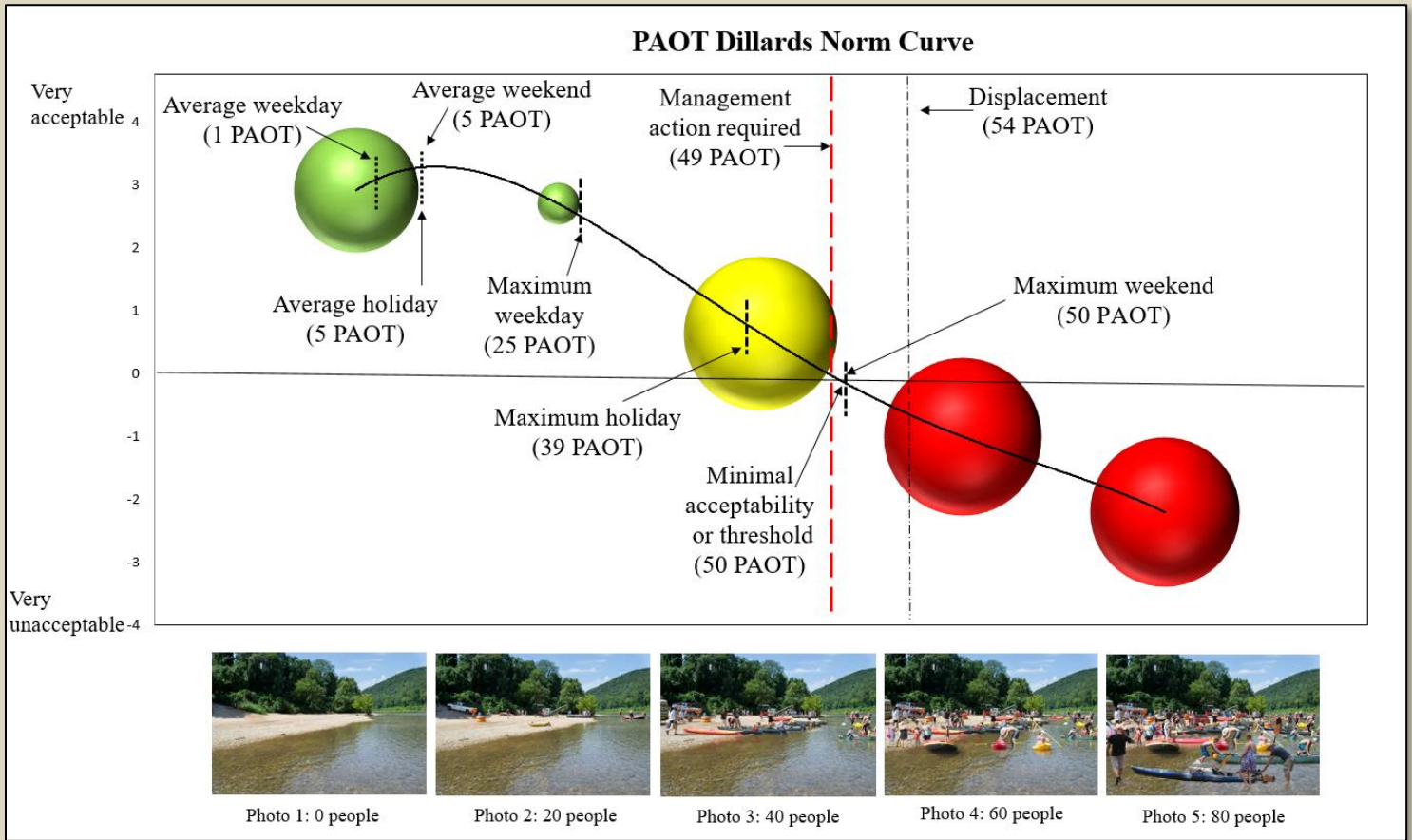


Figure 64. PAOT Dillard's norm curve. Green = acceptable conditions; Yellow = minimally acceptable conditions; Red = unacceptable conditions.

Table 24. PAOT seasonal maximums and averages PAOT at Dillard's.

Season	Max PAOT per Hour	Date & Time of Max PAOT	Average per Hour
Spring	17	4/15/17 15:45	0.98
Summer	50	6/17/17 17:30	6.57
Fall	44	10/16/16 13:28	2.91
Winter	11	2/11/17 10:15	0.43

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

In conclusion, the PAOT findings for Ponca Access, Kyle's Landing, Hasty Access, and Dillard's Ferry are summarized in Table 25. This table illuminates the similarity of PAOT findings at Ponca, Kyle's Landing, and Hasty. The difference between the three locations (Ponca, Kyle's Landing, and Hasty) and Dillard's is shown in Table 30. Dillard's was the location to have the highest PAOT thresholds.

Table 25. Summation table of PAOT findings.

	Minimal Acceptability Threshold	Management Action	Displacement
Ponca	20 PAOT	21 PAOT	22 PAOT
Kyle's Landing	23 PAOT	20 PAOT	22 PAOT
Hasty	23 PAOT	20 PAOT	22 PAOT
Dillard's	50 PAOT	49 PAOT	54 PAOT

Vehicles at One Time (VAOT)

The researchers also used field cameras to investigate Vehicles at One Time (VAOT) (Parking Lots Cameras referred to as PLCs). PLCs were stationed at the Compton Trailhead, Hathaway horseshoe-shaped Trailhead (referred to in the report from here on out as Hathaway 1), and the other Hathaway Trailhead located at the repeater radio tower (referred to in the report as Hathaway 2).

Compton Trailhead VAOT

The PLC at Compton Trailhead revealed that the parking lot receives high use, especially during the middle of the day (Figure 65). Spring is the busiest season at the Compton Trailhead, with an hourly average of 4.64 vehicles. Fall also has high levels of VAOT at the Compton Trailhead, with an hourly average was 4.50 vehicles (Table 26).

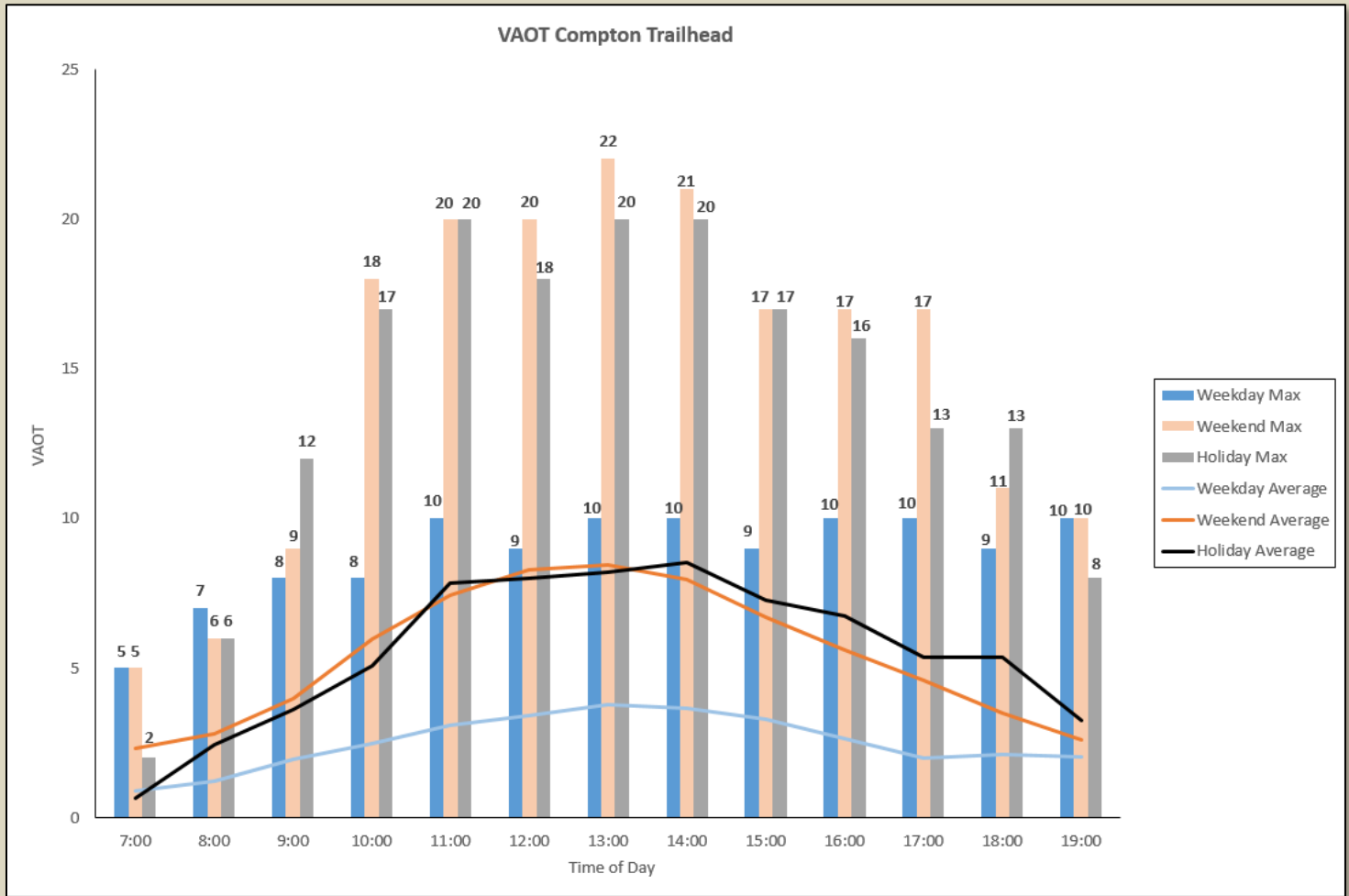


Figure 65. Compton Trailhead VAOT data.

Table 26. VAOT seasonal maximums and averages at Compton Trailhead.

Season	Max VAOT per Hour	Date & Time of Max VAOT	Average per Hour
Spring	22	4/8/17 13:30	4.64
Summer	13	6/10/16 13:45	2.66
Fall	10	10/10/16 14:15	4.50
Winter	19	2/11/17 12:15	2.88

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Hathaway 1 VAOT

The PLC data displayed in Figure 66 displays results for the Hathaway 1 Trailhead. The results indicate that this location does not experience high use, which is a finding experienced by researchers onsite during attempts to distribute questionnaires at this location. However, there is one exception: An equestrian event on 10/15/16, which is displayed in Figure 67. Hathaway 1 Trailhead has low seasonality, or restated that there is limited variability in use between seasons (Table 27). The researchers also analyzed statistics on the 10/15/16 event to determine if fall would still have the highest average per hour. Even with the data were removed from 10/15/16, fall would still have the highest average vehicles per hour at 0.53. Overall, these data reveal that the Lower Buffalo Wilderness receives limited use via access from Hathaway trailhead.

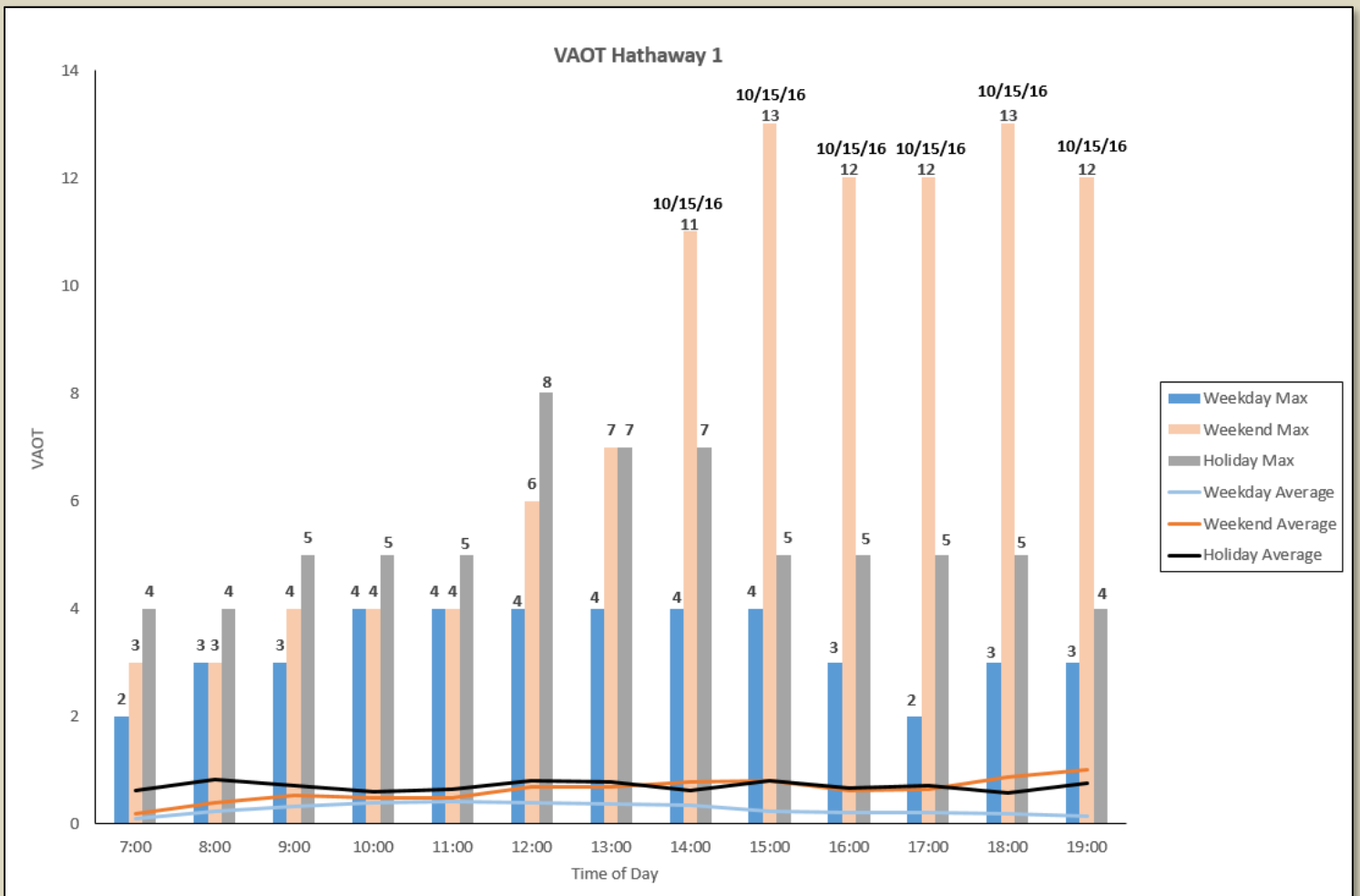


Figure 66. Hathaway 1 VAOT data.

Table 27. VAOT seasonal maximums and averages at Hathaway 1.

Season	Max VAOT per Hour	Date & Time of Max VAOT	Average per Hour
Spring	4	3/2/17 10:00	0.33
Summer	3	8/22/16 13:03	0.18
Fall	13	10/15/16 15:57	0.68
Winter	8	2/18/17 12:15	0.45

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.



Figure 67. Example picture of VAOT at Hathaway 1 in which parking capacity may have reached a maximum.

Hathaway 2 VAOT

The data for Hathaway 2 revealed infrequent use at the Hathaway 2 Trailhead (Figure 68). The seasonal hourly averages are all very small (Table 28). Table 33 does not include the dates and time of the seasonal maximums, because the maximums occurred on numerous occasions throughout each season at Hathaway 2. Overall, these data reveal that the Lower Buffalo Wilderness receives limited use via access from Hathaway trailhead.

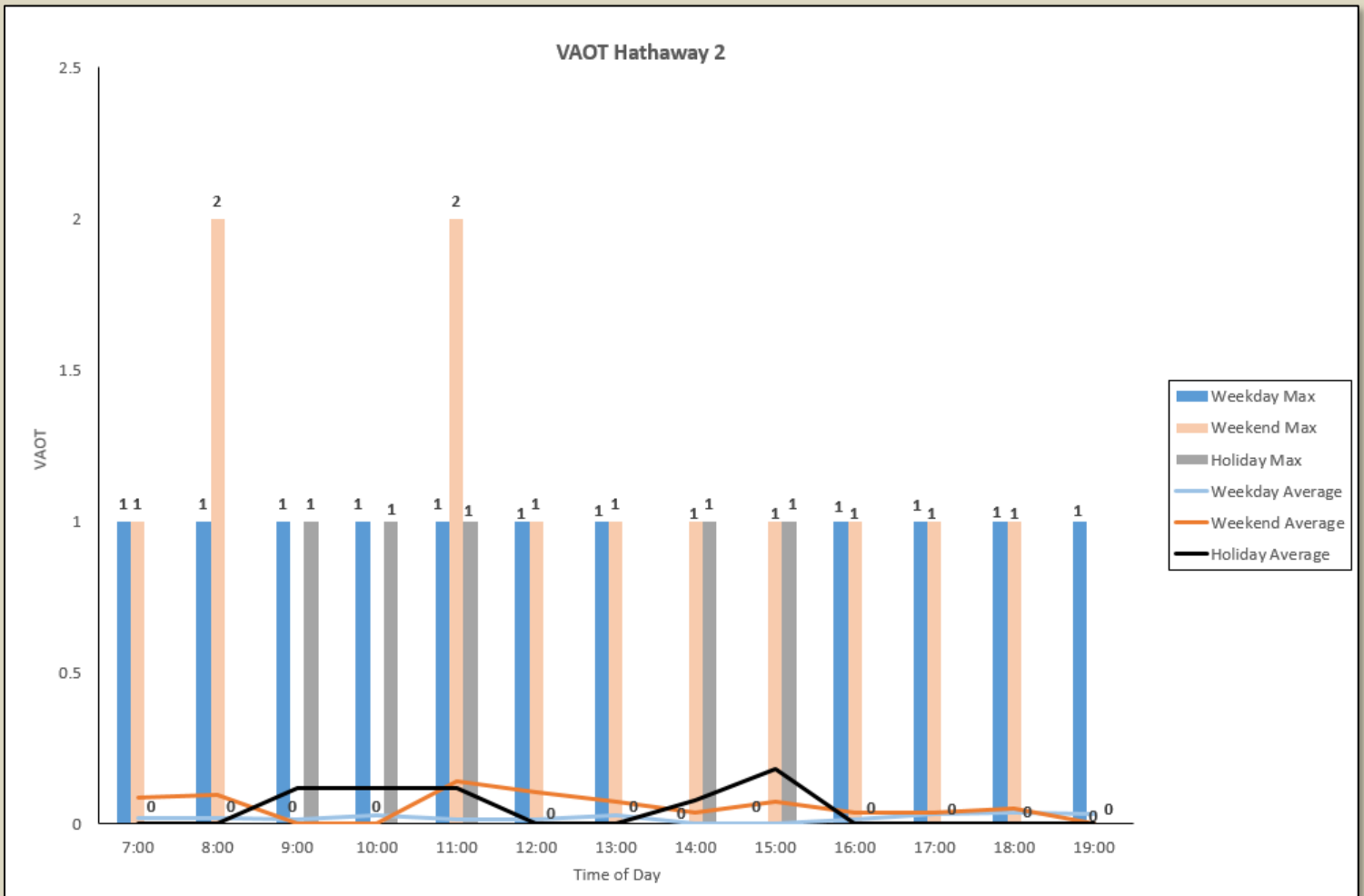


Figure 68. VAOT Hathaway 2 PLC data.

Table 28. VAOT seasonal maximums and averages at Hathaway 2.

Season	Max VAOT per Hour	Average per Hour
Spring	1	0.03
Summer	1	0.01
Fall	1	0.06
Winter	2	0.04

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Trail Counters

The researchers positioned six trail counters across the park unit: two at Hemmed in Hollow, two at Indian Rockhouse, and two at Gilbert. Both trail counters at Hemmed in Hollow and both trail counters at Indian Rockhouse are reported. The researchers chose to use the data from only one Gilbert trail counter since the two trail counters collected at Gilbert produced statistically similar data.

Hemmed in Hollow Trail Counters

The researchers placed two trail counters at Hemmed in Hollow (Figure 69). Trail Counter 1 was located to count the number of hikers traveling between Compton Trailhead and the Hemmed in Hollow Falls. Trail Counter 2 was positioned to count the number of hikers traveling between the river and the Hemmed in Hollow Falls.

The Hemmed in Hollow Trail proved to be a difficult location for trail counters. Hemmed in Hollow Trail Counter 1 was removed during the winter, and was transported to a new location during the spring, both instances occurring without researcher consent. Consequently, Hemmed in Hollow Trail Counter 1 data is missing for winter and spring. Similarly, the Hemmed in Hollow 2 Trail Counter was removed, without the consent of the researchers during the spring. Thus, Hemmed in Hollow 2 Trail Counter is missing data for the spring.

Figure 70 displays hourly data for Hemmed in Hollow Trail Counter 1, and Figure 71 displays hourly data for Hemmed in Hollow Trail Counter 2. Both locations receive similar usage. Tables 29 and 30 displays daily and seasonal data for Hemmed in Hollow 1 Trail Counter and Hemmed in Hollow Trail Counter 2 Trail Counter respectively. Both tables illuminate that Saturday is the busiest day for hiking to the Hemmed in Hollow Falls.

The data suggests that hikers in the area are not only visiting the falls but also continuing to the river prior to returning to Compton Trailhead.

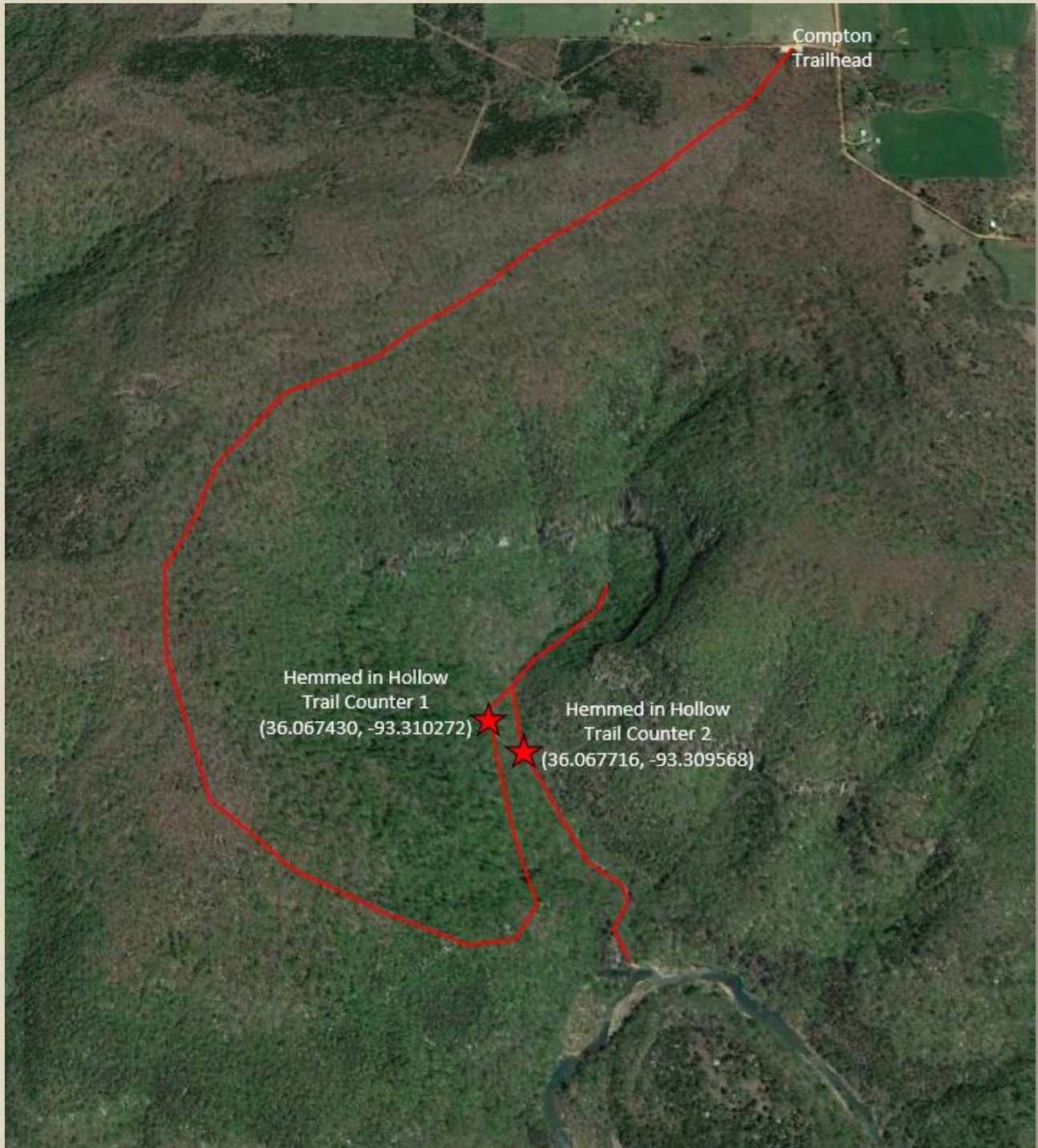


Figure 69. Map of the locations of the two trail counters at Hemmed in Hollow.

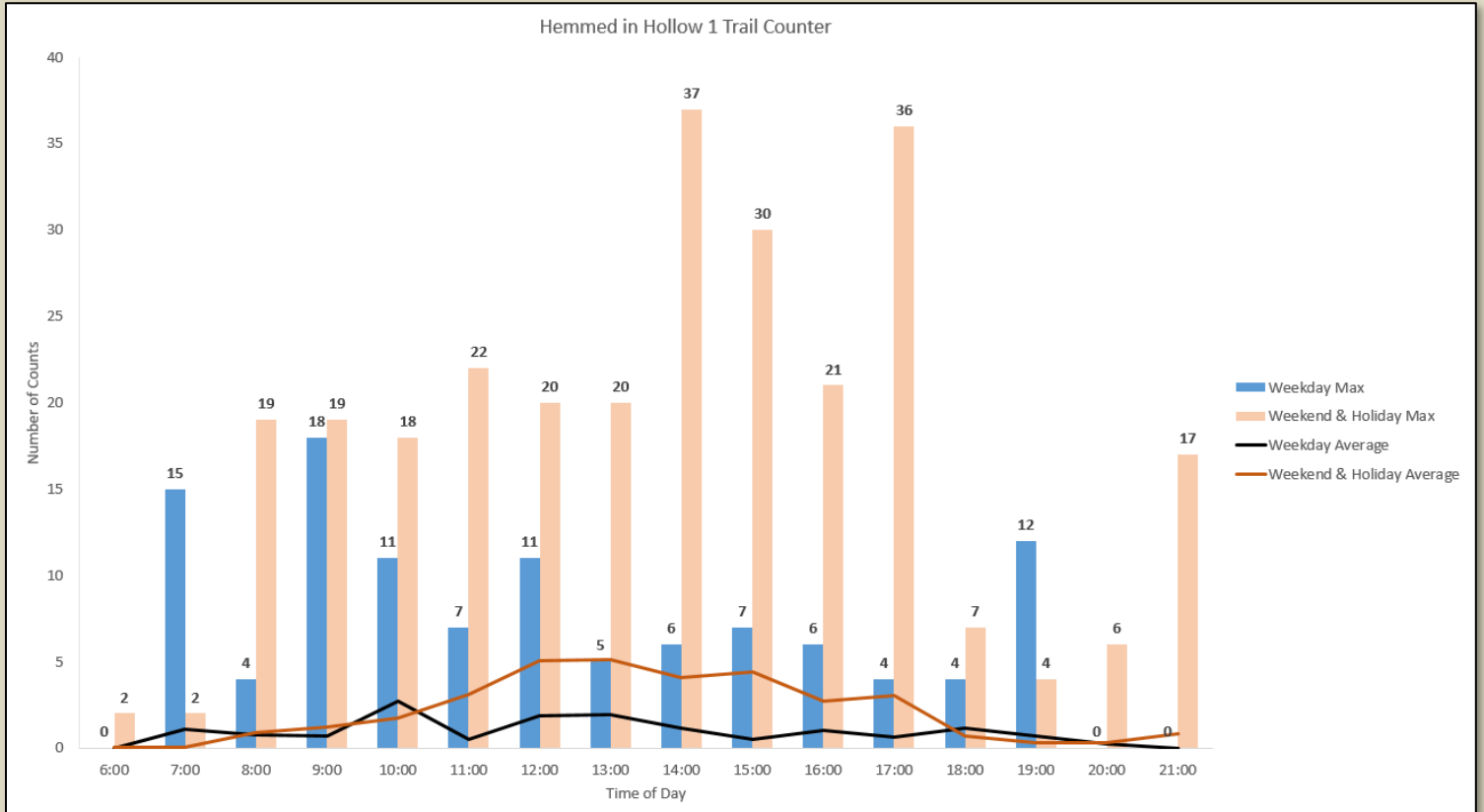


Figure 70. Hourly count data for Hemmed in Hollow Trail Counter 1.

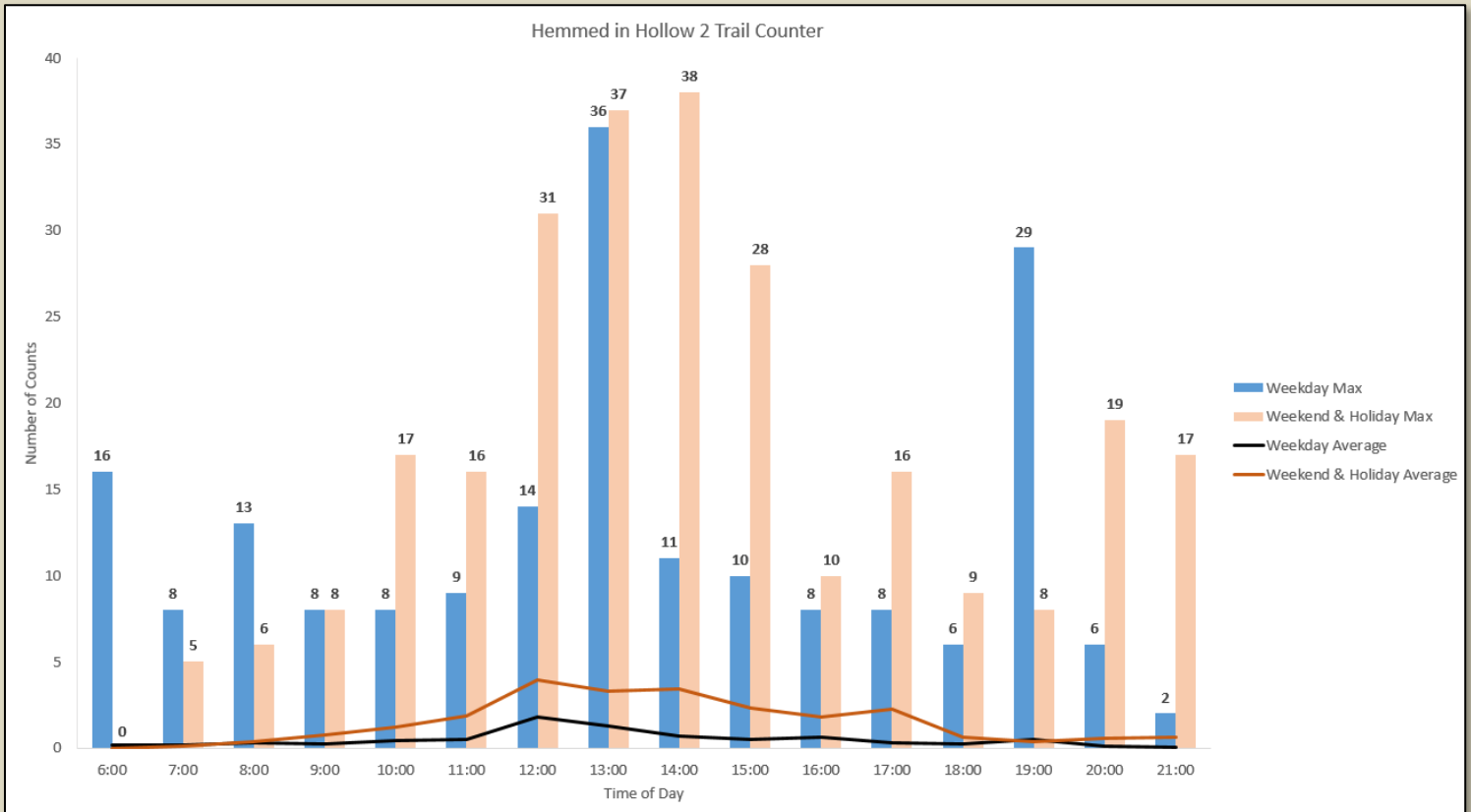


Figure 71. Hourly count data for Hemmed in Hollow Trail Counter 2.

Table 29. Daily trail counter data for Hemmed in Hollow Trail Counter 1.

Day	Hourly Max	Date & Time	Annual Hourly Average	Spring Hourly Average	Summer Hourly Average	Fall Hourly Average	Winter Hourly Average
Monday	22	9/5/16 11:00	0.84		0.53	1.06	
Tuesday	7	9/13/16 12:00	0.63		0.44	0.58	
Wednesday	15	11/30/16 7:00	2.44		0.73	1.09	
Thursday	4	8/18/16 13:00	0.16		0.43	0.16	
Friday	7	9/30/16 12:00	0.77		0.35	0.58	
Saturday	37	9/3/16 14:00	2.38		2.29	2.78	
Sunday	36	11/20/16 17:00	1.57		2.11	1.76	

Note. Trail counter averages were analyzed from 6am - 9pm. Hemmed in Hollow Trail Counter 1 went missing during the winter, and was moved without permission during the spring resulting in compromised data. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Table 30. Daily trail counter data for Hemmed in Hollow Trail Counter 2.

Day	Hourly Max	Date & Time	Annual Hourly Average	Spring Hourly Average	Summer Hourly Average	Fall Hourly Average	Winter Hourly Average
Monday	36	11/14/16 13:00	0.89		2.47	0.64	0.17
Tuesday	10	8/16/16 13:00	0.38		0.50	0.36	0.39
Wednesday	6	8/31/16 13:00	0.35		0.42	0.38	0.30
Thursday	29	8/11/16 19:00	0.37		1.00	0.28	0.28
Friday	16	10/22/16 11:00	0.66		0.42	0.57	1.54
Saturday	38	10/15/16 14:00	1.91		1.88	1.90	1.97
Sunday	17	10/16/16 10:00	1.07		0.69	1.33	1.47

Note. Trail counter averages were analyzed from 6am-9pm. Hemmed in Hollow Trail Counter 2 was removed without permission during the spring, which compromised spring data. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Indian Rockhouse Trail Counters

The researchers placed two trail counters at Indian Rockhouse (Figure 72). Trail Counter 1 was stationed to assess visitor travel patterns between the trailhead and Indian Rockhouse. Trail Counter 2 was located to assess visitor travel patterns of visitors traveling between Indian Rockhouse and the trailhead. Indian Rockhouse Trail Counter 1 recorded higher counts than Indian Rockhouse Trail Counter 2 (Figure 73, Figure 74, Table 31, Table 32). This finding suggests that visitors are using the east side of the loop more than the west, which is potentially a function of the location of the parking lot proximity to the east side of the trail. Saturday was determined to be the busiest day on the Indian Rockhouse Trail with the highest counts occurring in the middle of the day from approximately 11am-5pm.



Figure 72. Map of the locations of the two trail counters at Indian Rockhouse.

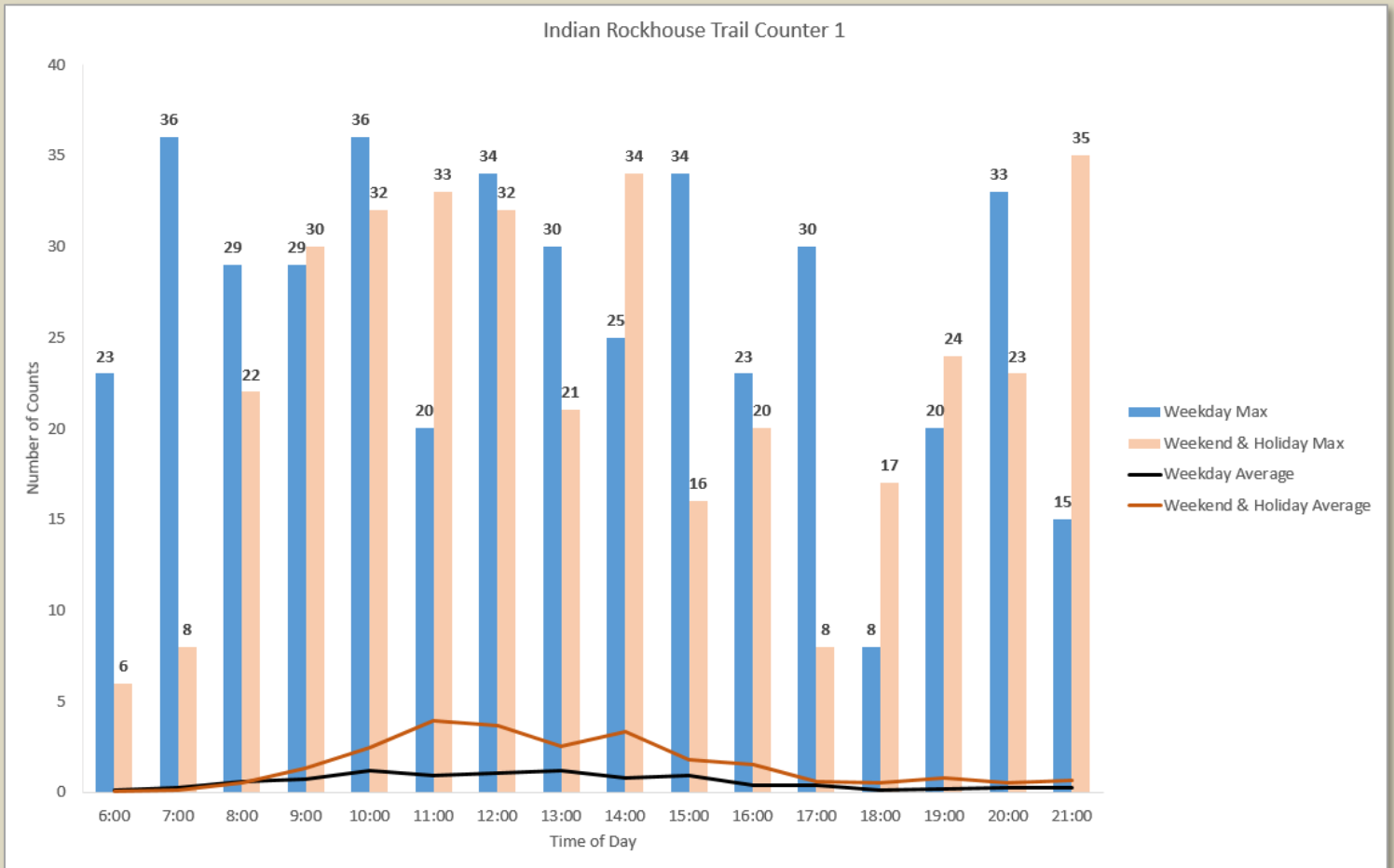


Figure 73. Hourly count data for Indian Rockhouse Trail Counter 1.

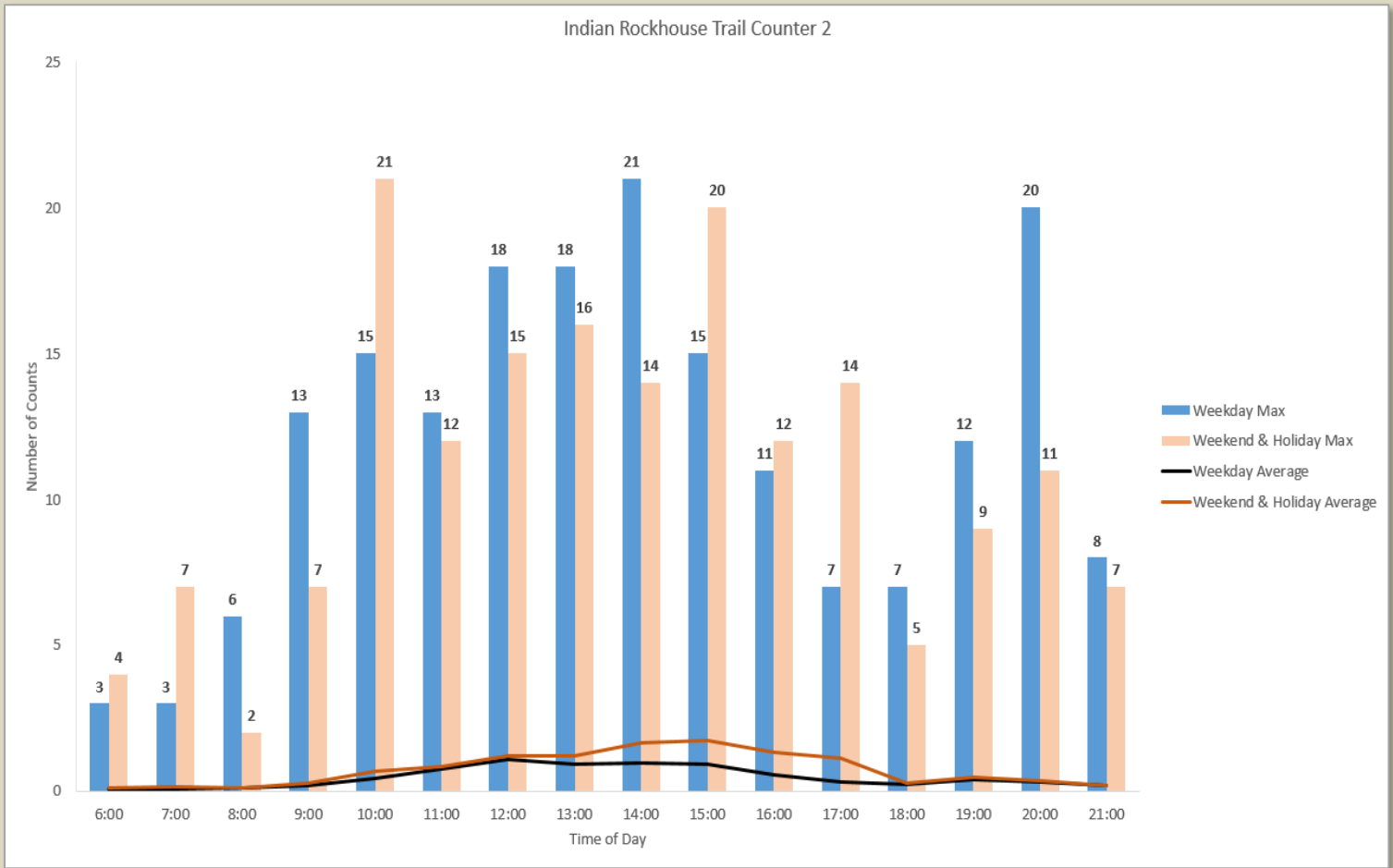


Figure 74. Hourly count data for Indian Rockhouse Trail Counter 2.

Table 31. Daily trail counter data for Indian Rockhouse Trail Counter 1.

Day	Hourly Max	Date & Time	Annual Hourly Average	Spring Hourly Average	Summer Hourly Average	Fall Hourly Average	Winter Hourly Average
Monday	35	8/15/16 10:00	0.60	0.41	2.17	0.62	0.09
Tuesday	29	7/18/17 9:00	0.40	0.31	1.08	0.40	0.19
Wednesday	30	5/24/17 17:00	0.54	0.65	1.36	0.38	0.21
Thursday	36	6/29/17 7:00	0.59	0.45	1.52	0.75	0.19
Friday	36	6/2/17 10:00	0.94	0.45	3.92	0.96	0.14
Saturday	35	7/1/17 21:00	1.78	0.79	3.55	3.34	0.43
Sunday	27	10/9/17 14:00	1.35	0.54	2.80	2.57	0.31

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Table 32. Daily trail counter data for Indian Rockhouse Trail Counter 2.

Day	Hourly Max	Date & Time	Annual Hourly Average	Spring Hourly Average	Summer Hourly Average	Fall Hourly Average	Winter Hourly Average
Monday	17	7/3/17 14:00	0.44	0.24	1.10	0.22	0.25
Tuesday	18	6/6/17 13:00	0.50	0.36	1.21	0.17	0.33
Wednesday	21	7/5/17 14:00	0.43	0.26	0.99	0.20	0.31
Thursday	14	3/16/17 17:00	0.49	0.32	0.98	0.42	0.27
Friday	20	6/16/17 20:00	0.49	0.20	1.08	0.38	0.31
Saturday	21	5/6/17 10:00	0.93	0.42	1.50	0.67	1.11
Sunday	14	6/25/17 15:00	0.64	0.27	1.17	0.38	0.75

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 - 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 - 11/30/17; Winter = 12/1/17 - 2/28/17.

Gilbert Trail Counter

Although two trail counters were stationed at Gilbert the data retrieved from each trail counter were statistically similar, thus only one Gilbert Trail Counter is reported. The Gilbert Trail Counter illuminated several findings (Figure 75, Table 33): 1.) Gilbert is regularly visited early in the day; 2.) On the weekdays Gilbert is frequently visited around lunch-time; 3.) On the weekends mid-afternoon has high visitation at Gilbert; 4.) Gilbert is most frequently visited on Saturdays; and 5.) Gilbert has large maximum counts.

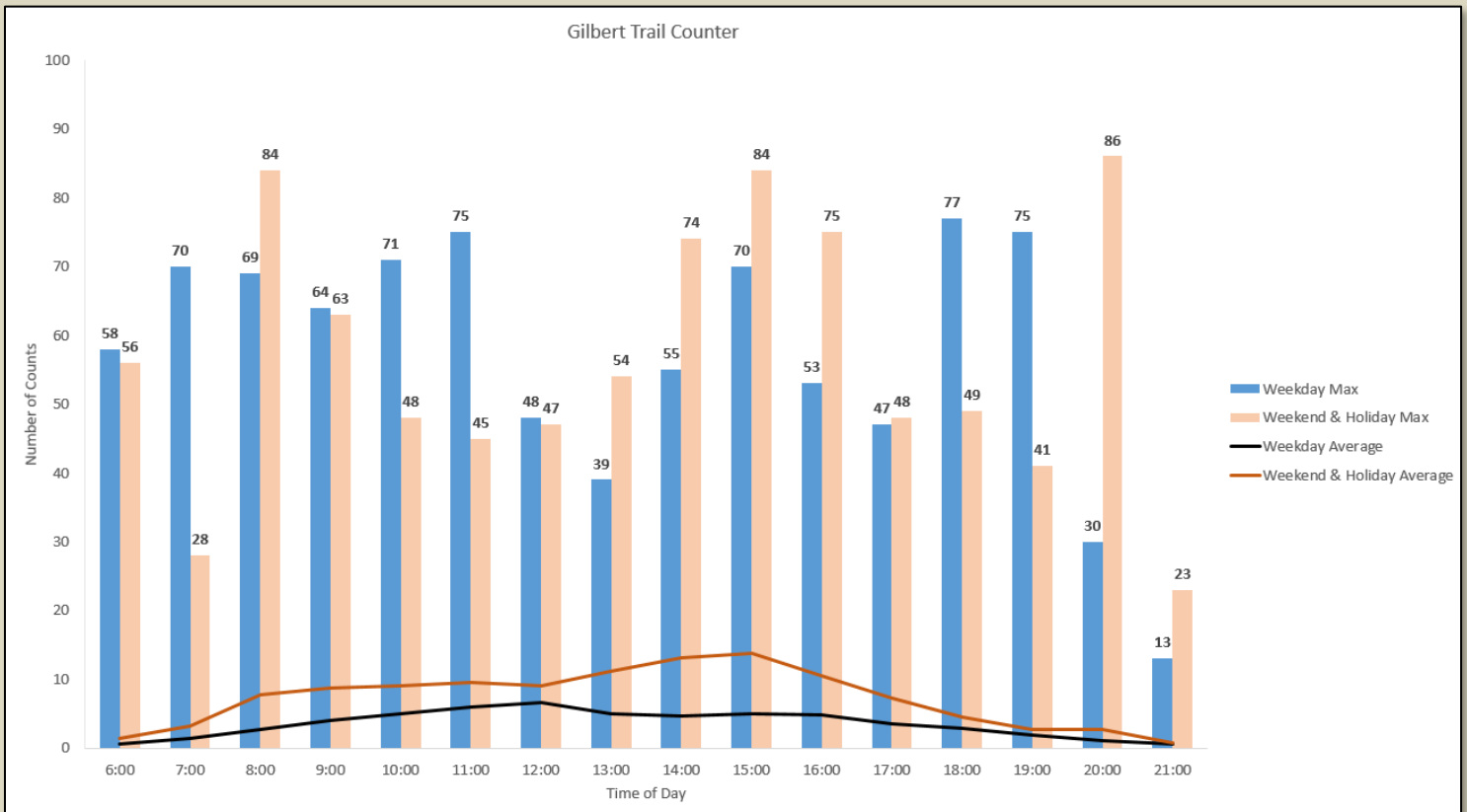


Figure 75. Hourly count data for Gilbert Trail Counter.

Table 33. Daily trail counter data for Gilbert Trail Counter.

Day	Annual Hourly Max	Date & Time	Annual Hourly Average	Spring Hourly Average	Summer Hourly Average	Fall Hourly Average	Winter Hourly Average
Monday	74	9/5/17 14:00	3.47	4.58	4.77	3.62	1.71
Tuesday	71	9/6/2016 10:00	3.11	4.80	2.75	3.64	1.38
Wednesday	58	7/5/2017 6:00	2.88	3.19	4.25	2.89	1.71
Thursday	77	5/25/17 18:00	3.51	4.78	5.73	3.14	1.56
Friday	75	6/9/17 19:00	4.76	5.15	8.53	5.06	2.06
Saturday	86	6/10/17 20:00	8.03	9.97	15.32	6.88	3.88
Sunday	84	5/14/17 8:00	6.20	6.02	12.08	5.97	3.27

Note. Spring = 3/1/17 - 5/31/17; Summer = 6/1/17 – 8/16/17 & 8/17/16 - 8/31/16; Fall = 9/1/17 – 11/30/17; Winter = 12/1/17 – 2/28/17.

Lower Buffalo Wilderness

The researchers surveyed all trailheads (Table 35) and trails in the Lower Buffalo Wilderness. Researchers hiked each trail until the trail dissipated and could not be identified. The researchers mapped the locations of the trailheads and trails in the Lower Buffalo Wilderness using field GPS units and aggregated in ArcMap GIS (Figure 76). Researchers labeled the trailheads with an orange circle, and the trail network is tan.

The researchers found trail impacts to be prominent in five locations in the Lower Buffalo Wilderness (Table 34), a relatively low number compared to other high use areas in other NPS units. This finding aligns with the VAOT data from Hathaway trailheads, as impacts and use are strongly related. Overall the trail system of the Lower Buffalo Wilderness receives low use, and consequently has experienced limited impact. Except for the five trail impact locations discovered by the researchers, the rest of the trails were not impacted. One location was discovered where litter was prominent (36.16154, -92.42610).

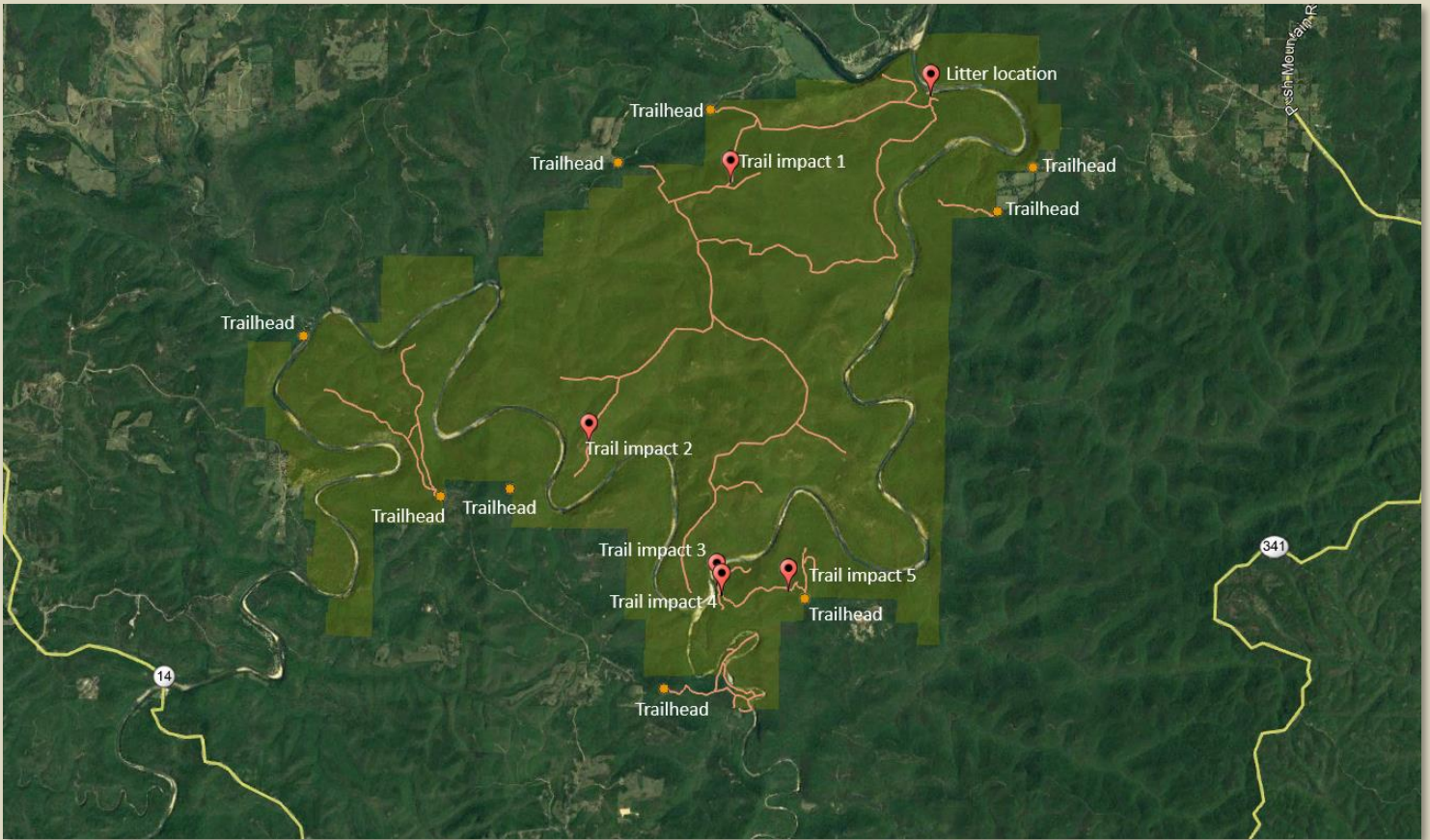


Figure 76. Map of the Lower Buffalo Wilderness displaying trail impact locations. The Lower Buffalo Wilderness trail network is in tan.

Table 34. The five trail impact sites and standardized measurements used to assess the degree of trail erosion.

	Location (decimal degrees)	Trail Width (inches)	Maximum Incision (inches)	Percent Mud	Height of Vegetation Above Trail	Trail Braiding	Rugosity
Trail impact 1	36.14735 -92.4659	50	12	0	>12ft	None	4.16
Trail impact 2	36.10554 -92.49384	70	5	90	>12ft	None	2.32
Trail impact 3	36.0832 -92.46863	30.5	9	0	>12ft	None	10.58
Trail impact 4	36.0816 -92.46766	37.25	11.25	0	>12ft	None	15.21
Trail impact 5	36.08242 -92.45861	21	6	0	>12ft	None	2.59

Note. Rugosity is a measure of the roughness of the trail. It is a measure of the variance along a transect line positioned perpendicular to the trail tread.

Table 35. Locations of the trailheads used to access the Lower Buffalo Wilderness.

Trailhead	Location (decimal degrees)
Hathaway TH	36.159349, -92.469868
Hathaway Radio Tower TH	36.150652, -92.488094
Rush Landing TH	36.123117, -92.55045
Road 650 TH	36.097519, -92.522871
Brantley Cemetery TH	36.098726, -92.50928
Log Wagon Gap TH	36.067, -92.479
Cold Spring School House TH	36.081, -92.451
Holsey Hollow 1 TH	36.143, -92.413

The researchers prepared an interactive Google Earth file (.kmz file) (Figure 77). The Google Earth file displays trail impacts locations and trailhead locations. When a trail impact location is selected in the file, Google Earth displays a picture of the trail section and also displays the standardized trail measurements taken at the location. When a Lower Buffalo Wilderness trailhead is selected, the coordinates of the trailhead is displayed.



Figure 77. An interactive Google Earth file of the Lower Buffalo Wilderness was submitted in conjunction with the Buffalo National River research report.

Flood

The following pictures are a sequence of pictures taken by the HBC stationed at Hasty during the April 29th, 2017 flood (Figure 78, Figure 79, Figure 80).



Figure 78. Late-morning of the April 29th flood.



Figure 79. Four-hour difference in water level from Figure 78.



Figure 80. The maximum height of the flood recorded by the researcher's HBC at Hasty.

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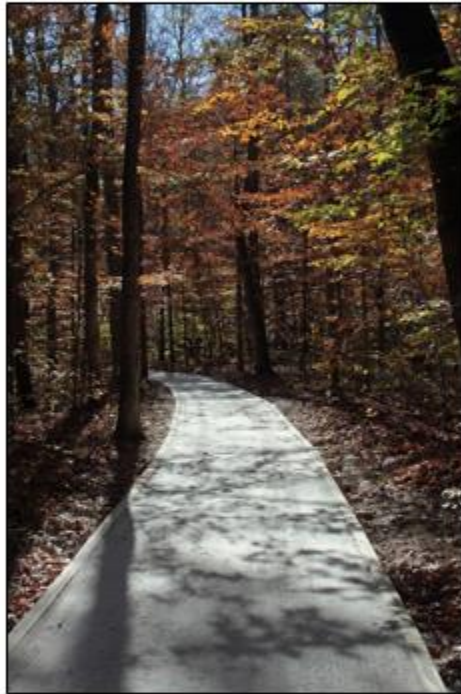
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Appendices

Appendix A – Preferences/Management Questionnaire (administered at Eden Falls trailhead)

Buffalo National River
Visitor Survey
(Preferences)
2016/2017



ID _____ Date _____ Location _____

Tracker _____ Field staff _____

Notes _____

SECTION 1: YOUR PAST AND CURRENT EXPERIENCE AT BUFFALO NATIONAL RIVER

1. Please tell us about your past use history at Buffalo National River. The term "outdoor recreation activities" refers to recreation-based activities at Buffalo National River (for example, fishing, hiking, swimming, canoeing, kayaking, rafting, tubing, wildlife watching, etc.):
 - a. Including today, how many **days in the last month** (30 days) have you used Buffalo National River for outdoor recreation activities? _____
 - b. Including today, how many **days in the last year** (12 months) have you used Buffalo National River for outdoor recreation activities? _____
 - c. Including today, how many **years (total)** have you used Buffalo National River for outdoor recreation activities? _____

SECTION 2: PREFERENCES AT BUFFALO NATIONAL RIVER

2. Please indicate your level of opposition or support for the potential expansion or creation of the following within the Lost Valley/Boxley area at Buffalo National River. **The list of items below are not necessarily actions that are definitely going to occur in the Lost Valley/Boxley area.** However, we are interested in your opinions about these potential actions. A rating of -3 means that you 'strongly oppose' and a rating of +3 means that you 'strongly support' the potential expansion or creation of the specific items below. *(Please circle one number for each row)*

	Strongly oppose	Oppose	Somewhat oppose	Neither oppose or support	Somewhat support	Support	Strongly support
Establish additional parking options at Lost Valley Trailhead	-3	-2	-1	0	1	2	3
Create a new campground	-3	-2	-1	0	1	2	3
Increase size of roadside pullouts for elk viewing	-3	-2	-1	0	1	2	3
Create new roadside pullouts for elk viewing	-3	-2	-1	0	1	2	3
Establish a visitor center	-3	-2	-1	0	1	2	3
Expand existing restroom facilities at Lost Valley Trailhead	-3	-2	-1	0	1	2	3

3. Please allocate 100 “preference points” for the potential expansion or creation of the following within the Lost Valley/Boxley area at Buffalo National River. For example, you might assign 100 points to one item and zero to all the others, or assign 50 points to one, 25 to another and 25 yet to another. Regardless of how you assign points, the points you assign should total 100. Please read through the list below and use the boxes to assign 100 preference points any way you would like. If you oppose any and all expansion or creation of infrastructure within the Lost Valley/Boxley area at Buffalo National River, you may indicate that below.

	Preference points
Establish additional parking options at Lost Valley Trailhead	
Create a new campground	
Increase size of roadside pullouts for elk viewing	
Create new roadside pullouts for elk viewing	
Establish a visitor center	
Expand existing restroom facilities at Lost Valley Trailhead	
TOTAL	100

I am choosing not to assign preference points to the list above because I oppose all expansion or creation of infrastructure within the Lost Valley/Boxley area at Buffalo National River.

4. If you could choose only one of the following to be potentially created or expanded within the Lost Valley/Boxley area at Buffalo National River which one would you choose? *(please select only one)*

I am choosing not to select one item from the list above because I oppose any and all expansion or creation

	Select one
Establish additional parking options at Lost Valley Trailhead	<input type="checkbox"/>
Create a new campground	<input type="checkbox"/>
Increase size of roadside pullouts for elk viewing	<input type="checkbox"/>
Create new roadside pullouts for elk viewing	<input type="checkbox"/>
Establish a visitor center	<input type="checkbox"/>
Expand existing restroom facilities at Lost Valley Trailhead	<input type="checkbox"/>

of infrastructure within the Lost Valley/Boxley area at Buffalo National River

5. Please indicate your level of satisfaction with the following services at Buffalo National River. A rating of -3 means that you are ‘very dissatisfied’ and a rating of +3 means that you are ‘very satisfied’ with the following services at Buffalo National River. (Please circle one number for each row)

	Very dissatisfied	Dissatisfied	Somewhat dissatisfied	Somewhat satisfied	Satisfied	Very satisfied
Cleanliness of restrooms	-3	-2	-1	1	2	3
Cleanliness of parking lots	-3	-2	-1	1	2	3
Cleanliness of trails	-3	-2	-1	1	2	3
Cleanliness of picnic areas or other gathering spots	-3	-2	-1	1	2	3
Condition of park roads	-3	-2	-1	1	2	3
Condition of trails	-3	-2	-1	1	2	3
Condition of parking lots	-3	-2	-1	1	2	3
Condition of signs	-3	-2	-1	1	2	3
Amount of restrooms available	-3	-2	-1	1	2	3
Amount of information available about the park	-3	-2	-1	1	2	3
Quality of information available about the park	-3	-2	-1	1	2	3

SECTION 3: ABOUT YOU

6. What is your zip code? _____
7. What year were you born? _____
8. What is your gender? (*select one*) Male Female Other
9. What is the highest level of school you have completed? (*select one*)
- | | | |
|--|---|--|
| <input type="checkbox"/> Less than high school | <input type="checkbox"/> Some college | <input type="checkbox"/> Graduate or professional degree |
| <input type="checkbox"/> Some high school | <input type="checkbox"/> Two-year college graduate | <input type="checkbox"/> Do not wish to answer |
| <input type="checkbox"/> High school graduate | <input type="checkbox"/> Four-year college graduate | |
10. What is your race? (*select all that apply*)
- | | | |
|---|---|--------------------------------|
| <input type="checkbox"/> American Indian or Alaska Native | <input type="checkbox"/> Hawaiian or Pacific Islander | <input type="checkbox"/> Other |
| <input type="checkbox"/> Asian | <input type="checkbox"/> Hispanic or Latino/Latina | |
| <input type="checkbox"/> Black or African American | <input type="checkbox"/> White | |
11. Which category best describes your total household income in U.S. dollars during 2015 before taxes?
(*select one*)
- | | | |
|---|---|---|
| <input type="checkbox"/> Less than \$24,999 | <input type="checkbox"/> \$50,000 to \$74,999 | <input type="checkbox"/> \$150,000 to \$199,999 |
| <input type="checkbox"/> \$25,000 to \$34,999 | <input type="checkbox"/> \$75,000 to \$99,999 | <input type="checkbox"/> \$200,000 or more |
| <input type="checkbox"/> \$35,000 to \$49,999 | <input type="checkbox"/> \$100,000 to \$149,999 | <input type="checkbox"/> Do not wish to answer |

Thank you for your help with this survey!

Please return it to the person who gave it to you.

PRIVACY ACT and PAPERWORK REDUCTION ACT statement:

16 U.S.C. 1a-7 authorizes collection of this information. This information will be used by park managers to better serve the public. Response to this request is voluntary and anonymous. Your name will never be associated with your answers, and all contact information will be destroyed when the data collection is concluded. No action may be taken against you for refusing to supply the information requested. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

BURDEN ESTIMATE STATEMENT: Public reporting burden for this form is estimated to average 10 minutes per response. Direct comments regarding the burden estimate or any other aspect of this form to:

Appendix B – Eden Falls Trails Questionnaire (administered at Eden Falls Trailhead)

Buffalo National River
Visitor Survey
(Trails)
2016/2017



ID _____ Date _____ Location _____
Tracker _____ Field staff _____
Notes _____

SECTION 1: YOUR PAST AND CURRENT EXPERIENCE AT BUFFALO NATIONAL RIVER
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1. Please tell us about your past use history at Buffalo National River. The term "outdoor recreation activities" refers to recreation-based activities at Buffalo National River (for example, fishing, hiking, swimming, canoeing, kayaking, rafting, tubing, wildlife watching, etc.):
 - a. Including today, how many **days in the last month** (30 days) have you used Buffalo National River for outdoor recreation activities? _____
 - b. Including today, how many **days in the last year** (12 months) have you used Buffalo National River for outdoor recreation activities? _____
 - c. Including today, how many **years (total)** have you used Buffalo National River for outdoor recreation activities? _____
2. How many people were in your travel party during your visit today? _____
3. Below is a list of activities available at Buffalo National River. Please indicate:
 - (A) The activities that were your main reason for visiting Buffalo National River
 - (B) The activities you participated in during this visit to Buffalo National River
 - (C) The activities you participated in during the past twelve months at Buffalo National River
 - (D) The location of the activities you participated in at Buffalo National River

	(A) Main reason for visiting (Check <u>only one</u>)	(B) Participated in on this visit (Check all that apply)	(C) Participated in during the <u>PAST 12 MONTHS</u> (Check all that apply) <i>Please list location of activity in column D</i>	(D) Location of activity
Horseback Riding	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Hiking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Camping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Nature/wildlife observation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Canoeing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Kayaking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Tubing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Visit Historic Sites	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other Specify: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

6. Please rate each photograph on **Poster 2** by indicating how acceptable you think it is based on the conditions displayed. A rating of -4 means the conditions displayed are "very unacceptable", and a rating of +4 means the conditions displayed are "very acceptable". (Circle one number for each photograph.)

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
Photo 1	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 2	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 3	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 4	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 5	-4	-3	-2	-1	0	+1	+2	+3	+4

- d. Which photograph looks most like the conditions you experienced today during this visit?

Photo number: _____

- e. Which photo (if any) displays the conditions where you believe park managers should take action to improve the area in **Poster 2**?

Photo number: _____ OR None of the conditions in the photographs are so unacceptable that park managers should take action to improve the area in Poster 2

- f. Which photograph (if any) displays the conditions that are so unacceptable that you would no longer use the area in **Poster 2**?

Photo number: _____ OR None of the conditions in the photographs are so unacceptable that I would no longer use the area in Poster 2

- b. Which photograph (if any) in Poster 2 shows the highest level of use that you believe park managers should allow? In other words, at what point should visitor use be limited? (If use should not be limited at any point represented by the photographs, or not restricted at all, you may indicate that)

Photo number: _____ OR None of the conditions in the photographs are so unacceptable that visitor use should be limited

OR Visitor use should never be limited

7. We would like to know how your opinions about encountering other people **during a one-hour period** on a trail at Buffalo National River. Using the scale below, please rate the acceptability of the number of other people encountered during a one-hour period on a trail. A rating of -4 means the number of other people encountered in one hour is "very unacceptable", and a rating of +4 means the number of other people encountered in one hour is "very acceptable". (Circle one number for each photograph.)

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
0 people in 1 hour on a trail	-4	-3	-2	-1	0	+1	+2	+3	+4
10 people in 1 hour on a trail	-4	-3	-2	-1	0	+1	+2	+3	+4
20 people in 1 hour a trail	-4	-3	-2	-1	0	+1	+2	+3	+4
30 people in 1 hour on a trail	-4	-3	-2	-1	0	+1	+2	+3	+4
40 people in 1 hour on a trail	-4	-3	-2	-1	0	+1	+2	+3	+4
50 people or more in 1 hour on a trail	-4	-3	-2	-1	0	+1	+2	+3	+4

a. Which conditions listed above is most like what you experienced today?

- 0 people in 1 hour on a trail
- 10 people in 1 hour on a trail
- 20 people in 1 hour on a trail
- 30 people in 1 hour on a trail
- 40 people in 1 hour on a trail
- 50 people or more in 1 hour on a trail

b. Which condition listed above do you believe would require park managers to take action to improve the trail experience at Buffalo National River

- 0 people in 1 hour on a trail
- 10 people in 1 hour on a trail
- 20 people in 1 hour on a trail
- 30 people in 1 hour on a trail
- 40 people in 1 hour on a trail
- 50 people or more in 1 hour on a trail

c. Which condition listed above is so unacceptable that you would no longer use the trails Buffalo National River?

- 0 people in 1 hour on a trail
- 10 people in 1 hour on a trail
- 20 people in 1 hour on a trail
- 30 people in 1 hour on a trail
- 40 people in 1 hour on a trail
- 50 people or more in 1 hour on a trail

SECTION 3: ABOUT YOU

8. What is your zip code? _____
9. What year were you born? _____
10. What is your gender? (*select one*) Male Female Other
11. What is the highest level of school you have completed? (*select one*)
- | | | |
|--|---|--|
| <input type="checkbox"/> Less than high school | <input type="checkbox"/> Some college | <input type="checkbox"/> Graduate or professional degree |
| <input type="checkbox"/> Some high school | <input type="checkbox"/> Two-year college graduate | <input type="checkbox"/> Do not wish to answer |
| <input type="checkbox"/> High school graduate | <input type="checkbox"/> Four-year college graduate | |
12. What is your race? (*select all that apply*)
- | | | |
|---|---|--------------------------------|
| <input type="checkbox"/> American Indian or Alaska Native | <input type="checkbox"/> Hawaiian or Pacific Islander | <input type="checkbox"/> Other |
| <input type="checkbox"/> Asian | <input type="checkbox"/> Hispanic or Latino/Latina | |
| <input type="checkbox"/> Black or African American | <input type="checkbox"/> White | |
13. Which category best describes your total household income in U.S. dollars during 2015 before taxes?
(*select one*)
- | | | |
|---|---|---|
| <input type="checkbox"/> Less than \$24,999 | <input type="checkbox"/> \$50,000 to \$74,999 | <input type="checkbox"/> \$150,000 to \$199,999 |
| <input type="checkbox"/> \$25,000 to \$34,999 | <input type="checkbox"/> \$75,000 to \$99,999 | <input type="checkbox"/> \$200,000 or more |
| <input type="checkbox"/> \$35,000 to \$49,999 | <input type="checkbox"/> \$100,000 to \$149,999 | <input type="checkbox"/> Do not wish to answer |

Thank you for your help with this survey!
Please return it to the person who gave it to you.

PRIVACY ACT and PAPERWORK REDUCTION ACT statement:

16 U.S.C. 1a-7 authorizes collection of this information. This information will be used by park managers to better serve the public. Response to this request is voluntary and anonymous. Your name will never be associated with your answers, and all contact information will be destroyed when the data collection is concluded. No action may be taken against you for refusing to supply the information requested. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

BURDEN ESTIMATE STATEMENT: Public reporting burden for this form is estimated to average 10 minutes per response. Direct comments regarding the burden estimate or any other aspect of this form to:

Appendix C – River Questionnaire (administered at Kyle’s Landing and Dillard’s Ferry)

Buffalo National River
Visitor Survey
(River)
2016/2017



ID _____ Date _____ Location _____
Tracker _____ Field staff _____
Notes _____

SECTION 1: YOUR PAST AND CURRENT EXPERIENCE AT BUFFALO NATIONAL RIVER

1. Please tell us about your past use history at Buffalo National River. The term "outdoor recreation activities" refers to recreation-based activities at Buffalo National River (for example, fishing, hiking, swimming, canoeing, kayaking, rafting, tubing, wildlife watching, etc.):
 - a. Including today, how many days in the last month (30 days) have you used Buffalo National River for outdoor recreation activities? _____
 - b. Including today, how many days in the last year (12 months) have you used Buffalo National River for outdoor recreation activities? _____
 - c. Including today, how many years (total) have you used Buffalo National River for outdoor recreation activities? _____

2. During your visit today:
 - a. Where did you put in, or enter the river? _____
 - b. What time did you put in, or enter the river? _____
 - c. What type of water craft did you use today?

 Canoe Kayak Raft Tube Other - write in: _____
 - d. Did you rent your water craft (canoe, kayak, tube, etc.) during this visit to the park? ___Yes ___No
 - e. Including you, how many people are in your group today? _____
 - f. Have you hiked the Hemmed-in-Hollow trail in the last 24 hours? ___Yes ___No

3. Below is a list of activities available at Buffalo National River. Please indicate:
 - (A) The activities that were your main reason for visiting Buffalo National River
 - (B) The activities you participated in during this visit to Buffalo National River
 - (C) The activities you participated in during the past twelve months at Buffalo National River
 - (D) The location of the activities you participated in at Buffalo National River

	(A) Main reason for visiting (<i>Check only one</i>)	(B) Participated in on this visit (<i>Check all that apply</i>)	(C) Participated in during the PAST 12 MONTHS (<i>Check all that apply</i>) Please list location of activity in column D	(D) Location of activity
Horseback Riding	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Hiking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Camping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Nature/wildlife observation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Canoeing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Kayaking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Tubing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Visit Historic Sites	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other Specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

6. Please rate each photograph on **Poster 2** by indicating how acceptable you think it is based on the conditions displayed. A rating of -4 means the conditions displayed are "very unacceptable", and a rating of +4 means the conditions displayed are "very acceptable". (Circle one number for each photograph.)

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
Photo 1	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 2	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 3	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 4	-4	-3	-2	-1	0	+1	+2	+3	+4
Photo 5	-4	-3	-2	-1	0	+1	+2	+3	+4

- d. Which photograph looks most like the conditions you experienced today during this visit?
- Photo number: _____
- e. Which photo (if any) displays the conditions where you believe park managers should take action to improve the area in **Poster 2**?
- Photo number: _____ OR None of the conditions in the photographs are so unacceptable that park managers should take action to improve the area in Poster 2
- f. Which photograph (if any) displays the conditions that are so unacceptable that you would no longer use the area in **Poster 2**?
- Photo number: _____ OR None of the conditions in the photographs are so unacceptable that I would no longer use the area in Poster 2
- g. Which photograph (if any) in **Poster 2** shows the highest level of use that you believe park managers should allow? In other words, at what point should visitor use be limited? (If use should not be limited at any point represented by the photographs, or not restricted at all, you may indicate that)
- Photo number: _____ OR None of the conditions in the photographs are so unacceptable that visitor use should be limited
- OR Visitor use should never be limited

7. We would like to know how your opinions about encountering other people **during a one-hour period** on the river at Buffalo National River. Using the scale below, please rate the acceptability of the number of other people encountered during a one-hour period on the river. A rating of -4 means the number of other people encountered in one hour is “very unacceptable”, and a rating of +4 means the number of other people encountered in one hour is “very acceptable”. (Circle one number for each photograph.)

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
0 people in 1 hour on the river	-4	-3	-2	-1	0	+1	+2	+3	+4
20 people in 1 hour on the river	-4	-3	-2	-1	0	+1	+2	+3	+4
40 people in 1 hour on the river	-4	-3	-2	-1	0	+1	+2	+3	+4
60 people in 1 hour on the river	-4	-3	-2	-1	0	+1	+2	+3	+4
80 people in 1 hour on the river	-4	-3	-2	-1	0	+1	+2	+3	+4
100 people or more in 1 hour on the river	-4	-3	-2	-1	0	+1	+2	+3	+4

- a. Which conditions listed above is most like what you experienced today?
- 0 people in 1 hour on the river
 - 20 people in 1 hour on the river
 - 40 people in 1 hour on the river
 - 60 people in 1 hour on the river
 - 80 people in 1 hour on the river
 - 100 people or more in 1 hour on the river
- b. Which condition listed above do you believe would require park managers to take action to improve the trail experience at Buffalo National River
- 0 people in 1 hour on the river
 - 20 people in 1 hour on the river
 - 40 people in 1 hour on the river
 - 60 people in 1 hour on the river
 - 80 people in 1 hour on the river
 - 100 people or more in 1 hour on the river
- c. Which condition listed above is so unacceptable that you would no longer use Buffalo National River?
- 0 people in 1 hour on the river
 - 20 people in 1 hour on the river
 - 40 people in 1 hour on the river
 - 60 people in 1 hour on the river
 - 80 people in 1 hour on the river
 - 100 people or more in 1 hour on the river

SECTION 3: ABOUT YOU

8. What is your zip code? _____
9. What year were you born? _____
10. What is your gender? (*select one*) Male Female Other
11. What is the highest level of school you have completed? (*select one*)
- | | | |
|--|---|--|
| <input type="checkbox"/> Less than high school | <input type="checkbox"/> Some college | <input type="checkbox"/> Graduate or professional degree |
| <input type="checkbox"/> Some high school | <input type="checkbox"/> Two-year college graduate | <input type="checkbox"/> Do not wish to answer |
| <input type="checkbox"/> High school graduate | <input type="checkbox"/> Four-year college graduate | |
12. What is your race? (*select all that apply*)
- | | | |
|---|---|--|
| <input type="checkbox"/> American Indian or Alaska Native | <input type="checkbox"/> Hawaiian or Pacific Islander | <input type="checkbox"/> Other |
| <input type="checkbox"/> Asian | <input type="checkbox"/> Hispanic or Latino/Latina | <input type="checkbox"/> Do not wish to answer |
| <input type="checkbox"/> Black or African American | <input type="checkbox"/> White | |
13. Which category best describes your total household income in U.S. dollars during 2015 before taxes? (*select one*)
- | | | |
|---|---|---|
| <input type="checkbox"/> Less than \$24,999 | <input type="checkbox"/> \$50,000 to \$74,999 | <input type="checkbox"/> \$150,000 to \$199,999 |
| <input type="checkbox"/> \$25,000 to \$34,999 | <input type="checkbox"/> \$75,000 to \$99,999 | <input type="checkbox"/> \$200,000 or more |
| <input type="checkbox"/> \$35,000 to \$49,999 | <input type="checkbox"/> \$100,000 to \$149,999 | <input type="checkbox"/> Do not wish to answer |

Thank you for your help with this survey!
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*Appendix D – Recommendations for Monitoring Conditions at BUFF***Recommendations for monitoring conditions at Buffalo National River (BUFF)**

This section describes the background and protocols for monitoring indicators for the visitor experience at BUFF. This includes the necessary tasks, procedures, sample design, data collection methodologies, equipment and use procedures, data recording methods, sequences, and standardizations necessary for data collection. Following this guide will help ensure that data collected will be objective, comparable, rigorous, and useful for the purposes of managing the quality of the visitor experience and related visitor carrying capacity of BUFF.

Need and background for monitoring the visitor experience

The Interagency Visitor Use Management Framework (2016) recommends that managers and researchers monitor indicators of quality and associated thresholds. If monitoring suggests that conditions are violating thresholds, or activating triggers, then responsible parties should consider management action. Management actions can include a variety of practices, including use limits, spatial or temporal redistribution of use, protection of the site from further impacts (e.g., site hardening), expansion of facilities or services, educating visitors in an attempt to reduce impacts, and direct mitigation (e.g., replanting areas of damaged vegetation). Monitoring of these indicators and their relationship to established thresholds and triggers needs to be a continuing process conducted by NPS staff. Alternatively, an external entity, such as a university familiar with the site and methods, can conduct the monitoring as part the Cooperative Ecosystems Studies Unit (CESU).

Monitoring protocols for selected indicators

Researchers and managers selected and prioritized the following indicators of quality for inclusion in the 2016-17 study and for future monitoring and management of the visitor experience at BUFF.

6. Crowding at Eden Falls
 - a. Operationalized as people at one time at Eden Falls
7. Crowding at river access areas
 - a. Operationalized as people at one time at a river access area
8. Congestion on the river
 - a. Operationalized as other boats within view at one time on the river
9. Crowding on the river
 - a. Operationalized as number of people encountered on the river during a one-hour period
10. Crowding on trails
 - a. Operationalized as number of people encountered on trail during a one-hour period

Monitoring protocol for “Crowding at Eden Falls: Operationalized as people at one time at Eden Falls”

Personnel should use the following steps to monitor crowding at Eden Falls.

Personnel conducting the monitoring should:

- 1) Use 2016 photo points at Eden Falls (location recorded using GPS in 2016 and identified in this report) for comparative viewsheds in future monitoring projects. This can be achieved by utilizing the recorded coordinates of prior photo points as well as photo referencing.
- 2) Secure a weather resistant, time-lapse camera at the photo point(s). Monitoring personnel may need a camera security box, padlock and/or cable lock.
- 3) Orient the camera to capture the same view as in previous data gathering efforts. It will be necessary to have a laptop computer during the setup of the camera to ensure this. Monitoring personnel should program the camera to capture photos every 15 minutes, beginning at sunrise and concluding at sunset. Researchers and managers often monitor visitor experience indicators during peak use periods and this timeframe includes the daily peak use period at BUFF.
- 4) Operate the camera for five consecutive days during the peak use period to maintain comparability. The measurement period should represent weekdays and weekends in relative proportion (e.g., Saturday through Wednesday for a five-day period). If the five-day monitoring period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then monitoring personnel should select a new monitoring period.

At the end of the data collection period, personnel facilitating the monitoring should remove the camera and download the pictures. Monitoring personnel should visually inspect each picture recording the people at one time at each 15-minute photo, recording the counts per time and day should in a spreadsheet. Monitoring personnel should calculate the hourly averages and maximum counts, and numerically compare the results to the baseline information, thresholds, and triggers presented in this report.

Monitor protocol for “Crowding at River Access Areas: Operationalized as people at one time at river access areas”

Personnel should use the following steps to monitor crowding at river access areas.

Personnel conducting the monitoring should:

- 1) Use 2016 photo points at Ponca, Kyle’s, Hasty, and Dillard’s (location recorded using GPS in 2016 and identified in this report) for comparative viewsheds in future monitoring projects. This can be achieved by utilizing the recorded coordinates of prior photo points as well as photo referencing.
- 2) Secure a weather resistant, time-lapse camera at the photo point(s). Monitoring personnel may need a camera security box, padlock and/or cable lock.
- 3) Orient the camera to capture the same view as in previous data gathering efforts. It will be necessary to have a laptop computer during the setup of the camera to ensure this. Monitoring personnel should program the camera to capture photos every 15 minutes, beginning at sunrise and concluding at sunset. Researchers and managers often monitor visitor experience indicators during peak use periods and this timeframe includes the daily peak use period at BUFF.
- 4) Operate the camera for five consecutive days during the peak use period to maintain comparability. The measurement period should represent weekdays and weekends in relative proportion (e.g., Saturday through Wednesday for a five-day period). If the five-day monitoring

period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then monitoring personnel should select a new monitoring period.

At the end of the data collection period, personnel facilitating the monitoring should remove the camera and download the pictures. Monitoring personnel should visually inspect each picture recording the people at one time at each 15-minute photo, recording the counts per time and day should in a spreadsheet. Monitoring personnel should calculate the hourly averages and maximum counts, and numerically compare the results to the baseline information, thresholds, and triggers presented in this report.

**The protocol described above can be adapted for monitoring at other river access areas as well. Conditions recorded through time-lapsed photography at smaller river access areas, similar in size to Ponca or Kyle's Landing, should be judged against the thresholds described in this report for Kyle's and Ponca. However, conditions recorded through time-lapsed photography at larger river access areas, similar in size to Dillard's Ferry, should be judged against the thresholds described in this report for Dillard's.

Monitoring protocol for "Congestion on the river: Operationalized as other boats within view at one time on the river"

Personnel should use the following steps to monitor congestion on the river.

Personnel conducting the monitoring should:

- 1) Construct a visitor survey with the following question: "Which photograph looks most like the conditions you experienced during this visit?" While answering this question, the monitoring personnel should provide visitors with the printed photos from the boats at one-time photo series in this report. Prior to administration, monitoring personnel should number each photograph (1, 2, 3, 4, or 5) and laminate for protection.
- 1) Future monitoring should occur with approximately 100 questionnaires, administering one to each travel group (i.e., 100 visitors). Monitoring personnel should administer 50 questionnaires at Kyle's Landing and 50 questionnaires at Dillard's Ferry. A random systematic sampling protocol (e.g., after a random start, asking every nth visitor group) should be used to select respondents, with visitors approached just before they depart from the landings at BUFF after their river experience. The survey will be self-administered, although staff should be available to assist respondents if needed. One individual should be selected from each group to complete the survey. This individual will be chosen from the group by selecting the person with the most recent birthday. If the individual chosen or the group refuses to participate in the survey, then the next eligible group to depart from the parking lot will be asked to participate.
- 2) The measurement period should represent weekdays and weekends in relative proportion (e.g., Saturday through Wednesday for a five-day period). If the five-day monitoring period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then a new monitoring period should be used.

At the end of the data collection period survey data should be placed into spreadsheets and compared to the baseline information, thresholds, and triggers presented in this report.

Monitoring protocol for “Crowding on the river: Operationalized as number of people encountered on the river during a one-hour period”

Personnel should use the following steps to monitor crowding on the river.

Personnel conducting the monitoring should:

- 1) Construct a visitor survey with the following question: “We would like to know your opinions about encountering other people during a one-hour period on the river at Buffalo National River” “Which of these conditions is most like you experienced today? (please select one).” While answering this question, visitors should be provided with the following options:

<input type="radio"/> 0 people in 1 hour on the river	<input type="radio"/> 60 people in 1 hour on the river
<input type="radio"/> 20 people in 1 hour on the river	<input type="radio"/> 80 people in 1 hour on the river
<input type="radio"/> 40 people in 1 hour on the river	<input type="radio"/> 100 people in 1 hour on the river

- 2) Future monitoring should occur with approximately 100 questionnaires, administering one to each travel group (i.e., 100 visitors). 50 questionnaires should be administered at Kyle’s Landing and 50 questionnaires should be administered at Dillard’s Ferry for comparability to the 2016-17 study. If other river sections are of interest, new monitoring locations can be selected and compared against future monitoring data but not against the 2016-17 data. A random systematic sampling protocol (e.g., after a random start, asking every nth visitor group) should be used to select respondents. Visitors will be intercepted just before they depart from the landings at BUFF after their river experience. The survey will be self-administered, although staff should be available to assist respondents if needed. One individual should be selected from each group to complete the survey. This individual will be chosen from the group by selecting the person with the most recent birthday. If the individual chosen or the group refuses to participate in the survey, then the next eligible group to depart from the area will be asked to participate.
- 3) The measurement period should represent weekdays and weekends in relative proportion (e.g., Saturday through Wednesday for a five-day period). If the five-day monitoring period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then a new monitoring period should be used.

At the end of the data collection period survey data should be placed into spreadsheets and compared to the baseline information, thresholds, and triggers presented in this report.

Monitoring protocol for “Crowding trails: Operationalized as number of people encountered on trail during a one-hour period”

Personnel should use the following steps to monitor crowding on trails

Personnel conducting the monitoring should:

- 4) Construct a visitor survey with the following question: “We would like to know your opinions about encountering other people during a one-hour period on a trail at Buffalo National River” “Which of these conditions is most like you experienced today? (please select one).” While answering this question, visitors should be provided with the following options:

<input type="radio"/> 0 people in 1 hour on a trail	<input type="radio"/> 30 people in 1 hour on a trail
<input type="radio"/> 10 people in 1 hour on a trail	<input type="radio"/> 40 people in 1 hour on a trail
<input type="radio"/> 20 people in 1 hour on a trail	<input type="radio"/> 50 people in 1 hour on a trail

- 5) Future monitoring should occur with approximately 100 questionnaires, administering one to each travel group (i.e., 100 visitors) at Eden Falls trailhead for comparability to the 2016-17 study. If other trails or trail sections are of interest, new monitoring locations can be selected and compared against future monitoring data but not against the 2016-17 data. A random systematic sampling protocol (e.g., after a random start, asking every *n*th visitor group) should be used to select respondents. Visitors will be intercepted just before they depart from the trail area after their hiking experience. The survey will be self-administered, although staff should be available to assist respondents if needed. One individual should be selected from each group to complete the survey. This individual will be chosen from the group by selecting the person with the most recent birthday. If the individual chosen or the group refuses to participate in the survey, then the next eligible group to depart from the area will be asked to participate.
- 6) The measurement period should represent weekdays and weekends in relative proportion (e.g., Saturday through Wednesday for a five-day period). If the five-day monitoring period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then a new monitoring period should be used.

At the end of the data collection period survey data should be placed into spreadsheets and compared to the baseline information, thresholds, and triggers presented in this report.

Data analysis and reporting for indicators of quality

A detailed spreadsheet (in Excel format) should be developed so that future monitoring data can be more easily organized, analyzed, and reported. This spreadsheet will 1) accept data in a standardized format, 2) analyze the data, 3) generate an annual monitoring report for each indicator, and 4) be used to track year to year trends in indicator variables. The spreadsheet should include the instructions in this section for use in future monitoring.

The following data reporting and analyses should occur after data:

- 1) All data should be descriptively reported in the form of tables, with measures of central tendency (i.e., mean, median, mode) and variability (i.e., standard deviation) where appropriate. Responses from upper and lower river and different sites should be reported separately.
- 2) Where possible, graphs showing indicator variables per day of the week and/or per time period should be developed.

Monitoring Schedule

For indicators to be useful for monitoring and managing the visitor experience (and carrying capacity) they *must* be monitored regularly. Researchers recommend that BUFF conduct monitoring as specified in this document on an annual or bi-annual basis. Also, researchers recommend that indicators, thresholds, and any information that these are based on (e.g., correction factors for counting, relationships between variables) be updated through a thorough visitor use study at a 5 to 10-year interval. This follow up study can be conducted by an external entity, such as a university familiar with the site and methods as part the Cooperative Ecosystems Studies Unit (CESU).

Monitoring additional visitor use data other than indicators of quality

Beyond indicators of quality, there are additional data used to understand the temporal and spatial distributions of visitor use. Understanding these distributions and levels of visitor use are often helpful when attempting to holistically interpret visitor use at a unit. Furthermore, monitoring these additional data can provide information to judge if a) visitor levels in specific areas have changed over time, b) specific seasons are witnessing increasing or decreasing use, and c) specific sites may warrant additional management attention and/or resources.

Specific to the study detailed in the report, managers and researchers selected and prioritized the following data.

- 6) Amount and distributions of use in the Compton Trailhead parking lot: Operationalized as vehicles at one time
- 7) Amount and distributions of use in the Hathaway Trailhead parking lots: Operationalized as vehicles at one time
- 8) Amount and distributions of use on the entry road to Gilbert Landing: Operationalized as number of interruptions on a vehicle counter
- 9) Amount and distribution of use for trails in the Hemmed in Hollow area: Operationalized as number of interruptions on a trail counter
- 10) Amount and distribution of use for trails in the Indian Rockhouse area: Operationalized as number of interruptions on a trail counter

Monitor protocol for “Amount and distributions of use in the Hathaway Trailhead parking lots and Compton Trailhead parking lot: Operationalized as vehicles at one time”

Personnel conducting the monitoring should:

- 1) Use 2016 photo points at Compton and Hathaway Trailheads (location recorded using GPS in 2016 and identified in this report) for comparative viewsheds in future monitoring projects. This can be achieved by utilizing the recorded coordinates of prior photo points as well as photo referencing.
- 2) Secure a weather resistant, time-lapse camera at the photo point(s). Monitoring personnel may need a camera security box, padlock and/or cable lock.
- 3) Orient the camera to capture the same view as in previous data gathering efforts. It will be necessary to have a laptop computer during the setup of the camera to ensure this. Monitoring

personnel should program the camera to capture photos every 15 minutes, beginning at sunrise and concluding at sunset. Researchers and managers often monitor visitor experience indicators during peak use periods and this timeframe includes the daily peak use period at BUFF.

- 4) Although the 2016-17 parking lot/vehicles at one-time data was evaluated across a calendar year, it is likely the selected monitoring period (Step 2 above) will be a short-period of time, such as two weeks. Consequently, for direct comparison, the trail count and vehicle count data presented in this report should be clipped to match the dates of the monitoring period. If the monitoring period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then monitoring personnel should select a new monitoring period.

At the end of the data collection period, personnel facilitating the monitoring should remove the camera and download the pictures. Monitoring personnel should visually inspect each picture recording the vehicles at one time at each 15-minute photo, recording the counts per time and day should in a spreadsheet. Monitoring personnel should calculate the hourly averages and maximum counts, and numerically compare the results to the baseline information, thresholds, and triggers presented in this report.

General monitoring protocol for trail and vehicle count data at Gilbert access road, Hemmed in Hollow trails, and Indian Rockhouse trails

Personnel conducting the monitoring should:

- 1) Identify the areas and data of interest for monitoring from the list above.
- 2) Determine the time-period for monitoring to establish a monitoring period. Researchers and managers often monitor visitor experience during peak use periods and this timeframe includes the daily peak use period at BUFF.
- 3) Use 2016 equipment points for sites of interest (location recorded using GPS in 2016 and identified in this report). This can be achieved by utilizing the recorded coordinates of prior equipment points as well as photo referencing.
- 4) Secure a weather resistant, trail or vehicle counter at the equipment point(s). Monitoring personnel may need a security box, padlock and/or cable lock.
- 5) Deploy and position the trail counter or vehicle counter following manufacturer recommendations. The 2016-17 study used Trafx trail counters for both vehicle and trail counters.
- 6) If the monitoring period presents non-typical conditions (e.g., unusually high rain, extreme temperatures, historical event), then monitoring personnel should select a new monitoring period.

At the end of the data collection period, personnel facilitating the monitoring should remove the equipment and download the data. Monitoring personnel should visually inspect the data for extreme cases or questionable cases, which may later be deleted if necessary. Following, monitoring personnel should record the counts per time and day in a spreadsheet. Monitoring personnel should calculate the hourly averages and maximum counts, and numerically compare the results to the baseline information, thresholds, and triggers presented in this report. Although the 2016-17 trail and vehicle count data was evaluated across a calendar year, it is likely the selected monitoring period (Step 2 above) will be a short-period of time, such as two weeks. Consequently, for direct comparison, the trail count and vehicle count data presented in this report should be clipped to match the dates of the monitoring period.

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