Evaluation of the Bear Viewing Experience and Associated Thresholds at Katmai National Park and Preserve and Lake Clark National Park and Preserve

2017-2020

Research Report

Cooperative Ecosystem Studies Unit (CESU)

Agreement Number P17AC01038

Final Project Report Prepared by (listed alphabetically):

Project Directors and Principle Investigators
Matthew T.J. Brownlee, Ph.D.[1]
Ryan L. Sharp, Ph.D.[2]

Project Coordinators
Dani Dagan, M.S[1]
Sarah Jackson, M.S[2]
John Nettles, M.S.[1]

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

[2]Applied Park Science Lab
Department of Horticulture and Natural Resources
Kansas State University
Manhattan, Kansas

Substantial assistance in data collection and report editing provided by Tyler Cribbs and Kelly Brady of the Park Solutions Lab at Clemson University. Additional assistance was provided by Dr. Joy Erlenbach of Washington State University.

[This page intentionally left blank]

EXECUTIVE SUMMARY

Project overview

The purpose of this research was to quantify relationships between visitor use and resource and social conditions at Katmai National Park and Preserve (KATM) and Lake Clark National Park and Preserve (LACL). This baseline information about backcountry visitors (i.e., those in all areas of the parks except Brooks Camp in KATM) can inform visitor use management and associated planning at KATM and LACL.

A normative approach guided the research process, reliant on indicators and thresholds. As a result, researchers used two phases of research. In the first phase, researchers developed indicators to evaluate both social and natural resource attributes related to backcountry and wilderness management in general, and the bear viewing experience specifically. In Phase 2, researchers measured thresholds for salient indicators and statistically verified the preliminary indicators, as well as collected data to determine the relationships between visitor use patterns and social conditions in key locations. This report focuses on the results of Phase 2 but refers to Phase 1 results (presented in a previous preliminary report; see Appendix A).

In Phase 2, researchers developed an online, quantitative, questionnaire to assess visitors' preferences for conditions experienced during their visit, as informed by responses to Phase 1. The researchers then distributed business cards with links to the questionnaire to visitors who recreated in backcountry areas of either KATM or LACL. While business cards were only distributed to backcountry visitors, some of these individuals may have also visited Brooks Camp during their trip. Potential respondents were encouraged to complete the survey within 14 days and were sent three subsequent reminder emails. Unless specified otherwise, data from KATM and LACL were combined for the subsequent analyses.

Lastly, additional research was conducted by Erlenbach et al. (2020) to assess visitor impacts on bear behavior and implications concerning habitat-specific management. Therefore, this corresponding research will be discussed further within this report.

The report is organized as follows: 1) introduction, research approach, and objectives; 2) description of methods and sampling; 3) initial results, demographics, and past use history; 4) overall normative thresholds; 5) analysis by intercept location; 6) additional analyses; 7) appendices.

Recommendations

Planning integration

- Consider integrating the results and outcomes of this project into park 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.

- Continue to develop potential management actions in the instance monitoring suggests that thresholds are violated, or triggers are activated. Consider pilot testing potential management actions prior to their full implementation to gauge their effectiveness.

Important indicators and associated thresholds

- When planning for management strategies and potential development in the region or park, consider the following visitor preferences and associated indicators and thresholds. However, these recommendations are only based on visitors' desires and should be balanced with other management considerations. The following visitor thresholds could be considered during park planning and when developing visitor use management strategies. These thresholds and associated findings are summarized in the following table (Table i).

    - The chance to view a bear at no closer than 9 yards and no farther than 220 yards at both KATM and LACL.

    - No more than 17 minutes of anthropogenic sound heard per hour at KATM and no more than 23 minutes of anthropogenic sound heard per hour at LACL.

    - No more than 6 other groups encountered per day at KATM or LACL.

    - No more than 6 fish caught per day with scarring at KATM.

    - No more than 48% of the vegetation surrounding angling sites degraded at LACL.

    - No more than 5 groups within view at one time at KATM and no more than 6 at LACL.

    - The chance to view at least one bear per hour and no greater than 17 bears per hour at both KATM and LACL.

Table i. *Summary of visitor survey results.*

Indicator	Threshold	Acceptable Range	Visitor Consensus	Quality of Current Experience	Impact of Current Conditions	Expected vs. experienced	% of visitors experiencing threshold violation
Proximity to bear	25-50 yds ideal	10-218 yards	Moderate	Moderate and acceptable	Increase the quality of experience	Four yards closer than expected	86% viewing bears 10-25 yards away
Minutes of human sound per hour	16-23 minutes per hour	0-15 minutes per hour	High	Moderate to low but acceptable	Slightly increase the quality of experience	Two minutes more per hour than expected	24%
Groups (3 to 6 people) encountered	6 groups per day	0-6 groups per day	Moderate	Moderate to low but acceptable	Neither increase nor decrease the quality of experience	One group more per day than expected	13%
Fish with scarring	6 fish per day	0-5 per day	High	Moderate and acceptable	Slightly increase the quality of experience	Equal	9%
Vegetation degradation at angling location	48% of an area	0-47% of an area	High to moderate	High	Increase the quality of experience	0.8% less than expected	4%
Groups (3 to 6 people) within view	5-6 groups within view	0-6 within view	High to moderate	Moderate and acceptable	Increase the quality of experience	Equal	11%
Bears viewed	At least 1 per hour	1-17 per hour	High to moderate	Moderate and acceptable	Increase the quality of experience	KATM: One more bear per hour than expected LACL: One fewer bear per hour than expected	16%

Monitoring Visitor Use

As resources allow, consider

- Following the monitoring of indicators described in this report. This would ensure that visitation changes resulting from management action are deliberately and appropriately evaluated for their efficacy.

- Following appropriate monitoring protocols prior to and after management action to determine the efficacy of action on use levels and perceived crowding.

- To better understand, visualize, and predict visitor use and dispersal as well as sites with higher potential for crowding or visitor conflict, incorporate utilization distributions into the management process.

- Developing unique management strategies for different activities. Some results discussed in this report suggest visitors participating in different primary activities may have different opinions about aspects important to their experience.

- The time-use pattern within each habitat type was not different across sites with differing degrees of human use, suggesting the time-use patterns may result primarily from the resources themselves, rather than human influence. Given that bears use salt marshes and salmon streams differently, management strategies to conserve natural behaviors of bears on the two habitat types should likely differ.

Key findings

(**See Appendix F for additional findings from research conducted by Erlenbach et al. (2020) concerning visitor impacts on bear behavior and habitat-specific management)*

Demographics

- On average, respondents were 53.5 years of age with gender slightly skewed towards males (59.9%).
- Overall, 43.2% of visitors reported receiving a graduate or professional degree, 32.2% received a four-year degree, and 7.9% received a high school diploma.
- Overall, 25.9% of visitors reported an annual household income of $200,000 or greater, 17.3% reported earning between $100,000 and $149,999, 11.6% reported earning between $150,000 and $199,999, and 19.3% declined to answer.
- Most respondents (75.3%) self-identified as white, 2.5% self-identified as Asian, and 5.7% declined to answer.
- Most domestic respondents were from California, Colorado, Alaska, or Texas, while most international respondents were from the United Kingdom.

Trip Characteristics and Past Use History

- The majority of respondents stated bear viewing (KATM: 54.8%; LACL: 38.8%) or angling (KATM: 25.9%; LACL: 26.3%) as their primary activity.
- Among backcountry visitors to KATM, 40.3% reported visiting the Valley of Ten Thousand Smokes, 30.5% reported visiting Brooks Camp, 28.7% reported visiting the Moraine/Funnel Creek Area, and 21.7% reported visiting Hallo Bay.
- Among backcountry visitors to LACL, 33.2% reported visiting Crescent Lake, 30.9% reported visiting Chinitna Bay, 20.6% reported visiting Silver Salmon Creek, and 15.2% reported visiting Twin Lakes.
- 73.4% of KATM visitors and 77.2% of LACL visitors were first-time visitors
- 44.8% of KATM visitors and 52.9% of LACL visitors spent less than 1 day at the park during their visit, with an average of approximately 6 hours spent in the park.

Level of Crowding Experienced

- Although visitors did not report feeling crowded, those who visited KATM reported higher levels of crowding (M = 1.85) than those who visited LACL (M = 1.37) (1=not crowded at all to 9=extremely crowded).

Threshold: Individual Distance to a Focal Bear

- Visitors to KATM expected to see bears at an average distance of 25.3 yards but experienced an average distance of 21.6 yards and an average closest distance of 12.7 yards.

- Visitors to LACL expected to see bears at an average distance of 29.5 yards but experienced an average distance of 24.3 yards and an average closest distance of 18.6 yards.

- Respondents from both parks reported 2 thresholds for acceptability: one at 8.7 yards (i.e., too close) and one at 219.6 yards (i.e., too far away).

- Approximately 69% of all respondents reported that none of the conditions presented to them in the questionnaire (10-100 yards) were poor enough to warrant management action or displacement.

Threshold: Anthropogenic Sound Heard per Hour

- Visitors to KATM expected to hear anthropogenic sound for an average of 12.1 minutes per hour but experienced an average of 13.0 minutes per hour with a maximum of 17.2 minutes per hour.

- KATM respondents reported a threshold for acceptability at 15.7 minutes of anthropogenic sound heard per hour, with management action required at 29.6 minutes, and displacement from the area occurring at 37.7 minutes.

- Visitors to LACL expected to hear anthropogenic sound for an average of 12.7 minutes per hour but experienced an average of 14.5 minutes per hour with a maximum of 17.7 minutes per hour.

- LACL respondents reported a threshold for acceptability at 22.5 minutes of anthropogenic sound heard per hour, with management action required at 31.0 minutes, and displacement from the area occurring at 39.2 minutes.

Threshold: Groups Encountered per Day (Groups = 3 to 6 people)

- Visitors to KATM expected to encounter an average of 3.5 other groups per day but experienced an average of 5.0 other groups per day.
- KATM respondents reported a threshold for acceptability at 6.2 other groups encountered per day, with management action required at 9.6 groups and displacement occurring at 11.8 groups.
- Visitors to LACL expected to encounter an average of 3.9 other groups per day but experienced an average of 4.1 other groups per day.
- LACL respondents reported a threshold for acceptability at 6.3 other groups encountered per day, with management action required at 9.1 groups and displacement occurring at 15.0 groups.

Threshold: Fish Caught per Day with Previous Scarring (KATM only)

- Visitors to KATM expected to catch 2.0 fish per day with visible scarring from previous angling efforts and experienced an average of 2.0 fish caught per day with scarring.
- KATM respondents reported a threshold for acceptability at 5.9 fish caught per day with previous scarring, with management action required at 7.4 fish and displacement occurring at 8.6 fish.

Threshold: Vegetation Degradation Surrounding Angling Sites (LACL only)

- Visitors to LACL expected to see an average of 10% of the vegetation degraded surrounding popular angling sites and experienced an average of 9.2% of the vegetation degraded.
- LACL respondents reported a threshold for acceptability at 48.7% degraded.
- Approximately 56% of all respondents reported that none of the five conditions presented in the questionnaire (0-75% degraded) to be poor enough to warrant management action or displacement.

Threshold: Groups within View at One Time (Groups = 3 to 6 people)

- Visitors to KATM expected to see an average of 2.5 other groups within view at one time and experienced an average of 2.9 groups within view.
- KATM respondents reported a threshold for acceptability at 5.1 groups within view.

- Visitors to LACL expected to see an average of 2.4 other groups within view at one time and experienced an average of 2.2 groups within view.

- LACL respondents reported a threshold for acceptability at 5.9 groups within view.

- Approximately 55% of all respondents reported that none of the five conditions presented to them in the questionnaire (0 to 10 groups) to be poor enough to warrant management action or displacement.

Threshold: Bears Viewed per Hour

- Visitors to KATM expected to see an average of 3.2 bears per hour and experienced an average of 4.0 bears per hour.

- Visitors to LACL expected to see an average of 3.0 bears per hour and experienced an average of 2.5 bears per hour.

- Respondents from both parks reported 2 thresholds for acceptability: one at 0.1 bears per hour (i.e., too few) and one at 17.2 bears per hour (i.e., too many).

- Approximately 80% of all respondents reported that viewing one bear per hour would be poor enough to warrant management action and displacement.

Impact of Current Conditions on Experience Quality

- Among KATM respondents, distance to a bear and bears viewed per hour had the greatest positive impact on the overall quality of their experience.

- Among LACL respondents, distance to a bear, groups within view, and lack of vegetation degradation had the greatest positive impact on overall experience quality.

Analysis by Intercept Location

- Visitors' ability to accurately recall the park sites they visited was higher among LACL visitors (93.7%) than among KATM visitors (66.4%), with the lowest accuracy at Hallo Bay (57.8%). In other words, 57.8% of visitors intercepted at Hallo Bay correctly identified that they visited the Hallo Bay area. This finding suggests that some visitors may not be aware of the park locations they visited.

- Respondents intercepted at Hallo Bay or Silver Salmon Creek reported higher levels of acceptability for bears at closer distances than did those intercepted at the King Salmon Airport or Port Alsworth.

- For anthropogenic sound heard per hour, visitors intercepted at Crescent Lake or Silver Salmon Creek (LACL) reported a higher tolerance for anthropogenic sound compared to those intercepted at Hallo Bay or the King Salmon Airport (KATM).

- For groups encountered per day, tolerance for higher use levels was significantly more among respondents intercepted at Silver Salmon Creek than those intercepted at Hallo Bay.

- For bears viewed per hour, respondents intercepted at Hallo Bay, Crosswinds Lake, Chinitna Bay, and Silver Salmon Creek reported much lower levels of acceptability for fewer bears than did those intercepted at the King Salmon Airport or Port Alsworth.

Linear Regression Analysis

- The average distance from bears experienced by visitors and the number of bears viewed per hour were found to be useful predictors of an individual's threshold for distance to a bear. This suggests that the onsite park experience potentially influences visitors' bear viewing distance preferences.

- The experienced condition was a significant predictor of an individual's threshold for groups within view, which suggests that the number of groups a visitor sees during a visit may influence their threshold for that indicator.

Anglers vs. Bear Viewers

- Race and income distributions did not differ between anglers and bear viewers, but a larger proportion of anglers (86.3%) identified as male than bear viewers (50.2%).

- Anglers tended to spend approximately one more day for multi-day users and one more hour for day users in the park than did bear viewers.

- On average, anglers reported having visited the park four more times in the last year and for one and a half more years total than did bear viewers.

- Anglers reported statistically higher levels of crowding than did bear viewers.

- Anglers tended to be more tolerant of viewing bears at farther distances than did bear viewers.

- Bear viewers tended to be slightly less tolerant of anthropogenic sound heard per hour than did anglers.

Crowding Density

- Given vegetation and topography considerations, varying levels of groups (3 to 6 people) can be present in different bear viewing areas before the crowding threshold is reached, allowing for 5.1 groups at the Kulik River viewing area, 4.3 groups at the Moraine/Funnel viewing area, and 3.9 groups at the Hallo Bay viewing area (see the Density Analysis section for a description and map of 'viewing areas' at each of the sites).

- Given vegetation and topography considerations, at LACL, varying levels of groups (3 to 6 people) can be present in different bear viewing areas before the crowding threshold is reached, allowing for 5.2 groups at the Silver Salmon Creek viewing area, 4.7 groups at the Chinitna Bay viewing area, and 2.4 groups at the Crescent Lake viewing area (see the Density Analysis section for a description and map of 'viewing areas' at each of the sites).

Utilization Distributions

- For KATM, over the last ten years, the intensity of use relative to other areas has decreased at Kulik River, increased at the Alagnak River and Lake Camp, and remained consistently high at Crosswinds Lake (Moraine Drainage and Funnel Creek Area) and Hallo Bay.

- Use is also expanding geographically at KATM, with sites like the Valley of Ten Thousand Smokes and Cape Douglas beginning to experience higher levels of use.

- As the summer progresses, the intensity of use at Hallo Bay and Geographic Harbor tends to decrease while that at Kulik River and the Moraine/Funnel area tends to increase and trips to Lake Camp and the Alagnak River remain fairly consistent.

- For LACL, the relative intensity of use does not seem to have changed or expanded geographically within the last ten years, but the intensity of use tends to increase throughout the summer at more coastal sites, including Silver Salmon Creek, Chinitna Bay, and Crescent Lake.

- There are high levels of overlapping use between anglers and bear viewers at the Moraine/Funnel area in KATM and both Silver Salmon Creek and Crescent Lake in LACL.

Habitat-specific Management of Bears and Bear Viewing

- Use has increased by 1,000% in recent years, thus possibly increasing pressure on bear behavior.

- Bear use at all sites occurred consistently beginning in mid-May with peak use in early July and diminishing around August 1.

- Visitor numbers followed the pattern of bear users, but this is because people are being brought to the sites to view the bears (and fish in some cases).

- Day use by visitors may have the least amount of impact on bear behavior as bears appear to be most active during morning and evening hours. However, habitat type appears to make a difference with salt marsh areas seeing continual use through the day, increasing over time.

- The higher highs and lower lows in the mornings and evenings may be a cue that bears are using to guide their fishing behavior. Bears could be using more inland portions of streams that are not affected by tides during midday and using the intertidal portions of the stream more during stronger morning and evening pulses.

- The relationship of higher morning and evening salmon stream use by bears with low midday use has been seen elsewhere (Quinn et al. 2014, Fischbach and Reynolds 2005; French 2010; Deacy et al. 2019, Warner 1987), including sites where people are not present (Deacy et al. 2019, Fischbach and Reynolds 2005; Warner 1987, Quinn et al. 2014) and across sites with a gradient of human use (Quinn et al. 2014).

- The pattern in time use of bears may not be the best indicator of whether human disturbance has taken place.

TABLE OF CONTENTS

EXECUTIVE SUMMARY iii
Project overview iii
Recommendations iv
Key findings vii

INTRODUCTION AND APPROACH 1
Introduction 2
Rationale 3
Normative theory 3
Objectives 5

METHODS 6
Descriptive Cross-sectional Sequential Design 7
Visitor Questionnaires 7
Identifying Indicators 8
Identifying Thresholds 9
Sampling Design 15
Detailed Sampling and Locations 16

INITIAL RESULTS 24
Combined Visitor Demographics 25
Home Locations of KATM Visitors 33
Home Locations of LACL Visitors 36
Visitor-Reported Locations 39
Past Use History 42
Level of Crowding Experienced 47

OVERALL NORMATIVE THRESHOLDS 48
Individual Distance to a Focal Bear 51
Anthropogenic Sound Heard per Hour 58
Groups Encountered per Day 62
Fish Caught per Day with Previous Scarring (KATM only) 65
Vegetation Degradation surrounding Angling Sites (LACL only) 67
Groups within View at One Time (GAOT) 71
Bears Viewed per Hour 77
Impact of Current Conditions on Experience Quality 82

ANALYSIS BY INTERCEPT LOCATION 86
Normative Thresholds 88
Individual Distance to a Focal Bear 88
Anthropogenic Sound Heard per Hour 92
Groups Encountered per Day 94
Fish Caught per Day with Previous Scarring (KATM only) 96
Vegetation Degradation surrounding Angling Sites (LACL only) 98
Groups within View at One Time (GAOT) 100
Bears Viewed per Hour 102

ADDITIONAL ANALYSES 105
Linear Regression Analysis 106
Predicting the Threshold for Distance to a Bear 107
Predicting Accuracy of Distance Estimates 109
Predicting Thresholds from Experienced Conditions 113
Comparing Anglers and Bear Viewers 114
Density Analysis 121
Utilization Distributions 124
Selecting locations 125
Analysis 127
Results 127
Discussion 133

References 134

Appendix A: KATM NPP Preliminary Research Report 2017-2018 138

Appendix B: LACL NPP Preliminary Research Report 2017-2018 166

Appendix C: References and Appendices for Preliminary Research Reports 2017-2018 196

Appendix D: Online Thresholds Questionnaire 2019-2020 210

Appendix E: Integrating Emotional Affect into Bear Viewing Management and Bear Safety Education 246

Appendix F: The Need for Habitat-specific Management of Bears and Bear Viewing 247

[This page intentionally left blank]

INTRODUCTION AND APPROACH

Introduction • **Rationale** • **Normative Theory** • **Objectives**

Introduction and Approach

Introduction

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, 2020). This protection-visitor use mandate is applicable to all NPS units, including Katmai National Park and Preserve (KATM) and Lake Clark National Park and Preserve (LACL). KATM and LACL both feature natural, cultural, and recreational resources that invite a population of visitors to backcountry and wilderness settings.

Established in 1918 as a national monument to preserve the area around the Novarupta-Katmai eruption, and made a national park through the Alaska National Interest Lands Conservation Act, KATM boasts over 4 million acres of remote and uninhabited landscape. KATM landscapes include volcanoes, robust fish and wildlife populations, and backcountry recreational opportunities (NPS, 2019a).

Similarly, LACL was established in 1978 as a national monument to preserve the Dena'ina people's ancestral homeland and later made a national park through the Alaska National Interest Lands Conservation Act. LACL includes over 4 million acres of wild landscapes, including rugged mountains, turquoise lakes, and true wilderness experiences (NPS, 2019b).

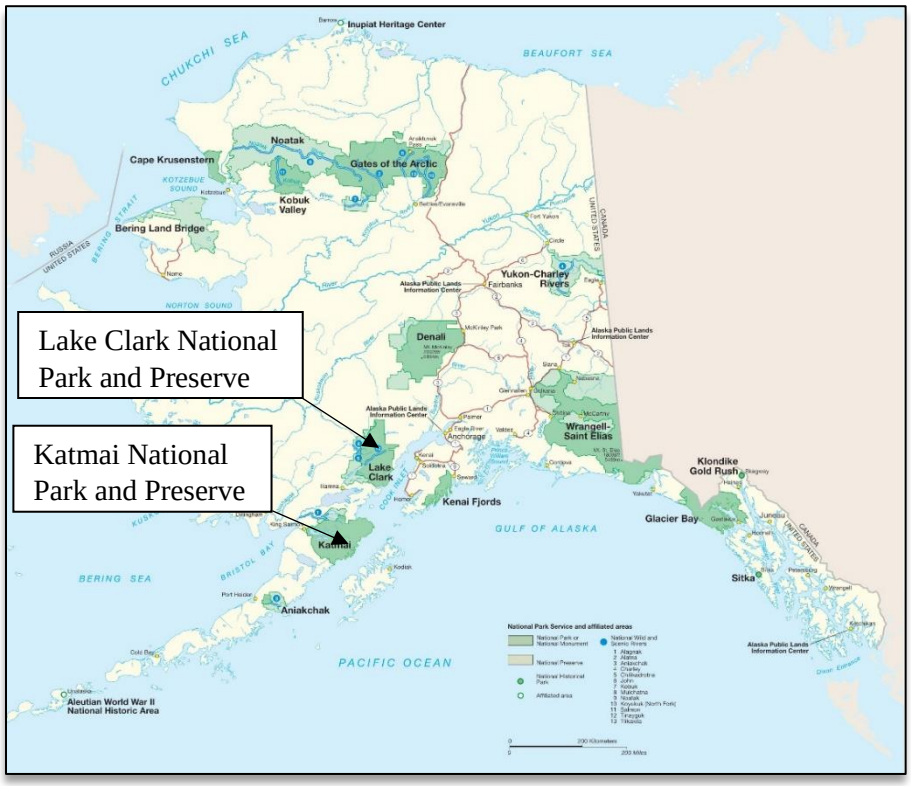


Figure 1. Location of Katmai and Lake Clark National Parks and Preserves in Alaska. Map adapted from Alaska.org (http://alaska.org/maps/national-parks-maps).

Rationale

Visitation has increased at KATM and LACL, and park managers continually strive to apply effective and efficient management strategies for addressing important visitor use issues and associated impacts. Specifically, visitation at KATM more than doubled from 2018-2019 however was consistent from 2015-2018. At LACL, visitation decreased from 2017-2018 but the park observed several thousand more visitors from 2018-2019.

Public land management occurs in a complicated environment that bridges social and environmental factors (Manning, 2011). While scientists and managers usually make decisions based on scientific evidence, wilderness visitors and managers may have diverging subjective evaluations of wilderness quality (Manning, 2011; Shin & Jackson, 1997). 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; Eagly & Chaiken, 1993; Kyle, Graefe, Manning, & Bacon, 2004). This research provides managers with information about visitors' opinions that can direct management decisions in an intentional and prescriptive manner (Borrie, Davenport, Freimund, & Manning, 2002; McLaughlin & Paradice, 1980). Management decisions are further reinforced when informed through the concurrent evaluation of human values and ecological conditions (Monz, Cole, Leung & Marion 2009).

Normative theory

Foundational to this report is normative theory, which broadly states that visitors have shared beliefs about aspects important to their experience (Manning, 2011). Normative Theory has been formally applied in similar settings since the 1980s. Central to understanding visitor use management through the utilization of normative theory is the concept of indicators and thresholds, which was incorporated by the Interagency Visitor Use Management Council (IVUMC), consisting of six government agencies: the National Park Service, the Bureau of Land Management, the U.S. Fish and Wildlife Service, the USDA Forest Service, the Army Corp of Engineers, and the National Oceanic and Atmospheric Association.

Measuring visitors' norms in parks often requires the use of indicators, thresholds, and evaluative dimensions. Indicators are measurable and manageable variables used in defining quality of an experience (IVUMC, 2016). Examples of potential indicators include the number of people in a viewscape at one time, the number of other groups encountered per day, or the number of wildlife observed. Potential indicators could also be ecological, such as habitat quality, or cultural, such as the number of degraded locations on a historical structure. Thresholds, or standards of quality, are the minimum acceptable condition of an indicator (IVUMC, 2016).

Most normative research allows managers and researchers to identify acceptability levels across a range of conditions. Other potential evaluative dimensions, or intended measures of an indicator, include the conditions that a visitor experienced at a park (i.e., experienced conditions), the condition that a visitor prefers (i.e., preferred conditions), conditions that are so bad that they warrant management action (i.e., management action), and conditions at which a

visitor would no longer visit the area due to degraded conditions (i.e. displacement). When interpreting results, it is important to consider all evaluative dimensions holistically in order to best represent average visitor opinions.

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, 2011 for a review). Specifically, the evaluations 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. 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, 2011). 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 (PCI_2) to evaluate 'norm crystallization,' or the level of agreement regarding visitors' evaluation of site conditions (Vaske, Beaman, Barreto, & Shelby, 2010). The PCI_2 spans from zero (maximum agreement; or minimal potential for conflict) to one (minimal agreement; or maximum potential for conflict), and it 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 PCI_2, 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 PCI_2 bubble), then managers can use the information from the normative investigations for management decisions (Krymkowski, Manning, & Valliere, 2009).

However, it is important to note that management objectives, indicators, and thresholds should not be formulated using only one information source, such as visitor opinion derived from a visitor survey. Instead, decisions should include considerations for all resource, social, and management components. The following report focuses heavily on the social components of experience (i.e., visitor opinions) and should, therefore, be used in conjunction with data regarding the resource and management components. Research can help to demonstrate

relationships between use levels and impacts but ultimately, defining thresholds typically requires managerial judgment supported by a range of information (Manning, 2011).

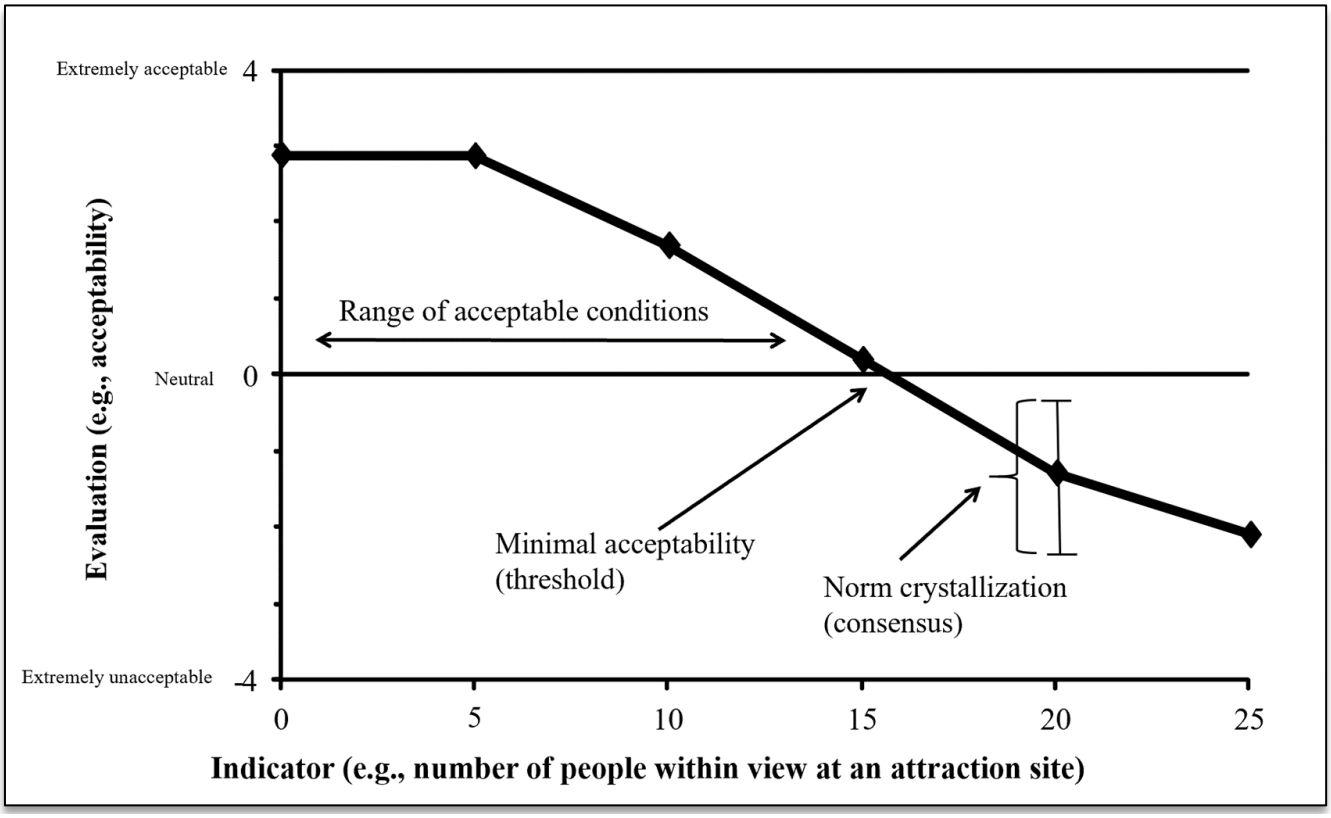


Figure 2. Example of social norm curve to identify visitors' threshold for number of people at one time at an attraction site.

Objectives

The purpose of this research was to quantify relationships between visitor use and resource and social conditions at KATM and LACL. This baseline information about backcountry and wilderness visitors (i.e., those in all areas of the parks except Brooks Camp in KATM) can inform visitor use management and associated planning at KATM and LACL.

Researchers used two phases to address the study purpose: 1) develop indicators to evaluate both social and natural resource attributes related to backcountry and wilderness management in general, and the bear viewing experience specifically; 2) measure thresholds for salient indicators and statistically verify the preliminary indicators and thresholds, as well as collect data to determine the relationships between patterns and ecological and social conditions in key locations. This report focuses on the results of Phase 2 but references Phase 1 results, which are presented in the preliminary report found in Appendix A.

METHODS

Visitor Questionnaires • **Identifying Indicators** • **Identifying Thresholds** • **Sampling Design**

Methods

Descriptive Cross-sectional Sequential Design

Although the research presented in this report consists of exploratory, descriptive, and explanatory components, it is largely descriptive. The research is cross-sectional, providing a 'snapshot' in time regarding visitor opinions about current and desired conditions. The design is also sequential with two phases, where metrics and approaches used in Phase 2 were informed by the findings from Phase 1. The unit of analysis is the individual park visitor, sampled in a fashion to generalize results to backcountry visiting populations at KATM and LACL.

Visitor Questionnaires

In Phase 1, the qualitative visitor questionnaire evaluated indicators of quality for visitors' experiences. Researchers also captured visitors' preferences regarding soundscapes, activities engaged in at KATM or LACL, information about sites visited and overnight use, and general demographics using standard U.S. Census Bureau categories. General demographics included zip code of primary residency, age, race, income, and education level. To gauge indicators of quality for visitors' experiences, the research team used an approach guided by the Visitor Use Management Framework (IVUMC, 2016).

Researchers conducted the survey using best practices for survey construction, such as those set forth by Vaske (2008) and Dillman (2011). The survey instrument was developed with input from park management. Iterative discussions with park management were integrated throughout the survey-writing process, and a phone conversation with commercial use authorized operators elicited comments on a draft questionnaire, many of which were incorporated into the final instrument. The questionnaire was approved by OMB and by the Institutional Review Board at Clemson University and Kansas State University.

The results of Phase 1 were used to aid the determination of potential indicators of quality measured in Phase 2. Recommendations based on initial findings were presented to park management through the preliminary report (Appendix A), and iterative discussions with park management were integrated throughout the decision-making process. KATM and LACL requested the following potential indicators of quality be tested:

- Distance to a bear
- Amount of time (per hour) human-produced noise was heard
- Number of other groups (3-6 people) encountered per day
- Number of scarred fish caught (KATM only)
- Amount of vegetation degradation surrounding popular fishing sites (LACL only)
- Number of other groups (3-6 people) within view
- Number of bears seen per hour

The specific indicators presented to each respondent were dependent on their self-reported primary activity (i.e. angling, photography, bear viewing, etc.) In Phase 1, a quantitative visitor questionnaire was distributed to backcountry and wilderness day use and overnight visitors, who

visited an area in either park other than Brooks Camp. Sampling for KATM occurred concurrently with sampling for a LACL study using largely the same survey instrument. In addition to on-site questionnaires, an online version of the questionnaire was solicited using a modified Dillman method (Dillman, 2011).

Responses from the questionnaires were entered into SPSS 24.0 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 and Bonferroni difference-of-means tests were used for all relevant statistical comparisons. Results do have some degree of measurement error because: a) the time between a visitor's experience and when they are able to complete the survey and b) responses are entirely self-reported, may have influenced accuracy of responses. However, all necessary precautions and additional analyses were taken to minimize any potential sources of error.

In accordance with agency and federal guidelines, 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 Clemson University approved the research methods after review from each institutions' Internal Review Board (IRB).

Identifying Indicators

Throughout the project, the research team met with KATM and LACL staff to discuss visitor use management and planning priorities. After these meetings and additional discussions with park staff, the research team selected seven total indicators of quality for the two studies (an indicator is a measurable, manageable variable that helps define the quality of a recreation experience).

1. Ability to see bears at a desired distance
    a. Operationalized as a visitors' proximity to a bear
2. Feelings of wilderness
    a. Operationalized as number of minutes hearing human-produced sound per hour
3. Feelings of solitude
    a. Operationalized as the number of other groups encountered per day
4. Damage to fish from repeated catch-and-release (KATM only)
    a. Operationalized as number of fish caught with visible scarring from previous angling efforts
5. Damage to streamside vegetation from frequent angling access (LACL only)
    a. Operationalized as amount of degraded vegetation surrounding a stream site
6. Crowding at backcountry sites
    a. Operationalized as number of other groups within view
7. Ability to see bears frequently
    a. Operationalized as the number of bears seen per hour

Identifying Thresholds

Visual approaches to measuring thresholds were employed using computer-generated photographs to represent a range of groups at one time and an individual's distance to a bear. 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.

When measuring visitors' preferences and thresholds for personal proximity to a bear, visitors were asked to study multiple photographs that depicted a range of conditions from proximal (10 yards) to distal (100 yards). Researchers constructed study photographs by taking baseline photographs of backcountry sites with visitors and bears at various distances, using range finders to record precise distances between the camera and the focal individual. These photographs were used to measure pixel height of individuals at desired distances. Knowing pixel height, actual height, and metadata from the photograph, the researchers used online calculators (*scantips.com*) as well as hand calculations to determine required pixel height of the focal bear. A single focal bear was edited from a previous photograph and inserted into baseline photographs at previously calculated pixel heights using Adobe Photoshop. Special care was taken by the researchers to move the focal bear only from the foreground to the background, with no shift from left to right. Any altered photographs were reviewed by all members of the research team and submitted to the park for approval prior to their inclusion in the survey. Although these distances were calculated and precisely measured, the photo depiction may have resulted in a perceived distance that is farther away than intended. If this is the case, results may be slightly lower than what visitors intended. However, when asked to estimate the distance depicted, responses of visitors varied heavily in both directions (page 109).

Similarly, when measuring visitors' preferences and thresholds for crowding at backcountry sites, visitors were asked to study multiple photographs that depicted a range of conditions from solitude (e.g., no other groups) to saturation (e.g., a large number of groups). Researchers constructed study photographs by taking baseline photographs of backcountry sites, with varying numbers of groups present. These photographs were aggregated, layered, and modified in Adobe Photoshop to depict a range of conditions that occur or could occur at KATM or LACL. The research team paid special attention to depict crowding realistically at KATM and LACL, which involved using typical group sizes (3-6 people) and dispersal seen in baseline photographs and onsite field observations. As discussed in the density analysis section of the report, the research

team calculated the farthest distance a group could be placed within the photo while remaining visible. Given site vegetation and topographical variation, this distance was estimated as 0.25 miles.

To measure visitors' preferences and thresholds for vegetation degradation surrounding popular angling sites (LACL only), visitors were asked to study multiple photographs that depicted a range of conditions from pristine (0% degraded) to heavily altered (70% degraded). Researchers constructed study photographs by taking preliminary photographs of backcountry sites and anglers, with varying amounts of vegetation degradation. A photo with zero degradation but high potential for degradation was selected as the baseline photograph. To provide context, an angler was edited out of a previous photograph and inserted into the baseline photograph using Adobe Photoshop. With preliminary photographs as examples, the researchers continued to use Adobe Photoshop to artificially degrade the surrounding vegetation at five different percent levels. The research team paid special attention to depict vegetation realistically at LACL. Again, all altered photographs were reviewed by all members of the research team and submitted to the park for approval prior to their inclusion in the survey.

To quantitatively assess the level of degradation in each of the computer-manipulated photos, the researchers used Microsoft PowerPoint to overlay a grid on each photo. Grids were drawn over portions of the photo considered available to be degraded, meaning the stream itself, as well as vegetation in the background of the photo, were not included. Grids were drawn 10 cells high and 40 cells across. Two of these ten rows (highlighted in blue) were excluded as they covered only the stream, leaving a total of 320 cells. For each photograph, the researcher highlighted all cells with degraded vegetation red. The percent of total cells that contained degraded vegetation (highlighted red) was calculated and used during analysis. Survey respondents were only presented with the photographs and were not shown these percentages (see Figure 6).

Photographs were presented to visitors within the online survey format. 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 condition that: a) they expected to see, b) they actually experienced, c) management action should occur, and d) they would no longer use the area (displacement). While photographs were used throughout the online survey for varying topics, this method was not used to measure anthropogenic sound or fish scarring. For these specific topics, scales were implemented within the online survey and respondents were asked to select the most appropriate answer(s) based on their experiences within KATM and LACL.

Photo 1: 10 yards

Photo 2: 25 yards

Photo 3: 50 yards

Photo 4: 75 yards

Photo 5: 100 yards

Figure 3. Photos series used to identify thresholds for personal proximity to a bear, as depicted from 10 to 100 yards away

Photo 1: 0 groups

Photo 2: 2 groups

Photo 3: 4 groups

Photo 4: 6 groups

Photo 5: 8 groups

Photo 6: 10 groups

Figure 4. Photo series used to identify thresholds for crowding in terms of groups within view, depicting between 0 and 10 groups

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Figure 5. Photo series used to identify thresholds for vegetation degradation surrounding an angling site, using five images with worsening conditions.

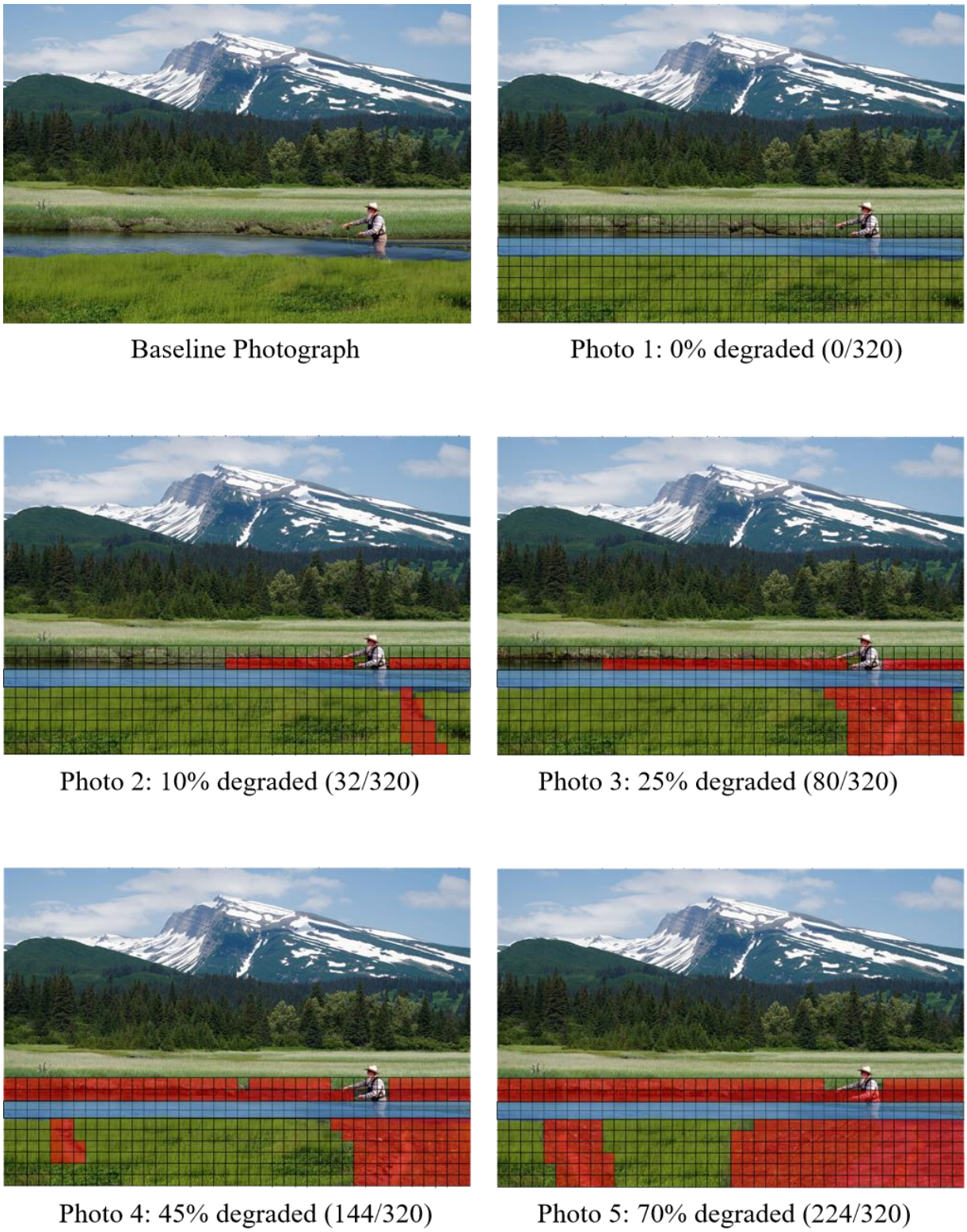


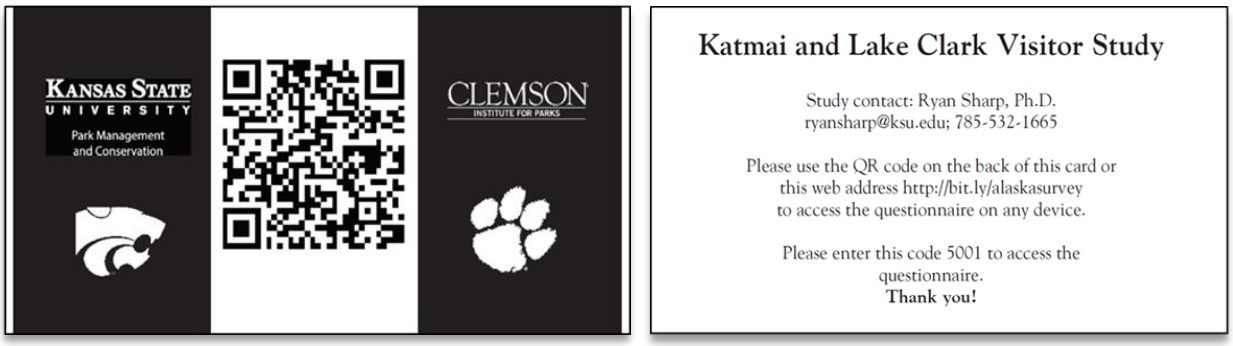
Figure 6. Edited photo series used to calculate percent of vegetation degradation within altered photographs, depicting 0 to 70% degraded.

Sampling Design

Questionnaires were distributed at eight intercept points, including two regional travel sites near KATM and LACL and six park locations. To ensure a representative sample while attaining a sufficient sample size, researchers used a stratified random sampling procedure (Vaske, 2008) and distributed surveys at relatively high-use locations. Trained research assistants intercepted visitors at both parks during peak season from June 23 through August 10.

In all cases, each intercepted visitor who was 18 years of age or older was asked to complete the online survey at their earliest convenience but within a three-week period. At field locations, researchers executed an entry briefing, where they introduced themselves and the research, upon the visitor's arrival when possible. Then, researchers either distributed cards immediately or identified an appropriate time and location for later distribution. Special care was taken by the research team to limit burden on visitors and minimize time taken away from their experience.

Using this method, visitors were provided with a business card that included both a URL and QR code to access the survey, as well as a unique access code with which researchers were able to track survey completion. Researchers collected an email address and correlated it with each card's access code, and three reminder emails were sent one week, two weeks, and three weeks following business card distribution.



a) Front View b) Rear View

Figure 7a and 7b. Sample business card distributed to KATM and LACL visitors.

In Phase 2, sampling involved only the online version of the questionnaire (Appendix D). This decision was made to minimize the time of a visitor's experience occupied by the survey. Guides, commercial use authorized operators, and visitors reacted largely positively to the adjusted sampling procedure. Although very similar, two different survey instruments were developed, one for KATM and one for LACL. Business cards were park-specific and in instances where visitors spent time in both parks, approximately half of each group received business cards for each park, or all received cards for both parks. Both forms of the online survey were created and managed using Qualtrics Survey Software version 1.3.01. This allowed the research team to create a survey with complex skip patterns and verification methods that were used to ensure respondents not only have qualified for the survey (i.e. visited LACL or outside of

Brooks Camp in KATM) but receive questions tailored to their self-identified primary activity. For example, a visitor who listed their primary activity as angling received questions regarding fish scarring, while a visitor who listed their primary activity as bear viewing received questions regarding the number of bears viewed per hour. Furthermore, Qualtrics software not only provides an intuitive design that is easy for questionnaire participants to use but compiles the data for efficient data management as well.

Detailed Sampling and Locations

Business cards directing visitors to questionnaires were distributed at eight high-use intercept points, including two regional travel corridors, sites in KATM, and sites in LACL. Due to the concurrent nature of sampling at LACL and KATM, visitors who visited any backcountry or wilderness area in at least one of these parks were asked to complete a questionnaire regardless of the intercept location. As visiting populations are similar between parks, survey results from KATM and LACL are often combined. However, separate questionnaires allowed us to identify KATM or LACL visitors regardless of their intercept location.

a) Typical visitor intercept at Crosswinds Lake. Visitors were approached after deplaning and were solicited for online survey completion while guides gathered gear.

b) Typical visitor intercept at Hallo Bay. Depending on timing, visitors were approached and solicited for online survey completion shortly before or after guides gave a brief safety talk.

Figure 8a & 8b Typical visitor intercepts in KATM and LACL.

To ensure a representative sample while attaining a sufficient sample size, researchers used a stratified random sampling procedure (Vaske, 2008) and distributed surveys at relatively high-use locations across backcountry and wilderness areas of KATM and LACL, as well as in main regional travel corridors, according to peak use times identified through informal interviews with park staff and visitor resources provided on the park website (NPS, 2018). Sites were selected in such a way as to diversify visitation in terms of location (coastal or interior visitors) and activity type (anglers, bear viewers, both or neither). The sites are: Crosswinds Lake (Moraine/Funnel Creeks) (KATM), Hallo Bay (KATM), King Salmon Airport (King Salmon, AK), Chinitna Bay

(LACL), Crescent Lake (LACL), Port Alsworth (LACL), Silver Salmon Creek (LACL), and Upper Twin Lakes/Proenneke Cabin (LACL). Planned surveyor locations were adjusted frequently throughout the season, resulting in the schedule reported in Table 1.

Figure 9. Sampling locations in KATM

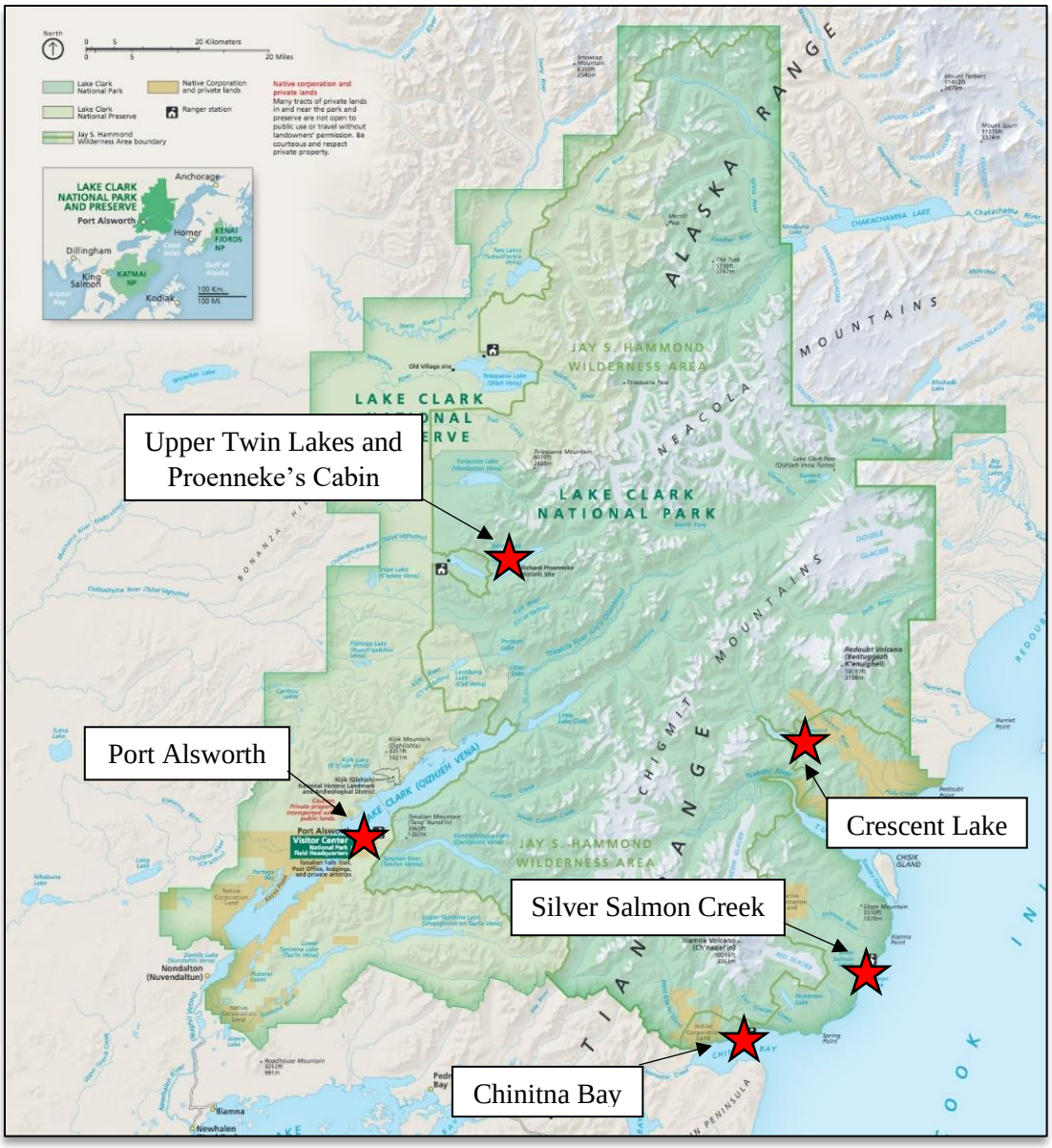


Figure 10. Sampling locations in LACL

Table 1. *Number of Clemson and Kansas State University research assistants present at each location.*

	Crosswinds Lake	Hallo Bay	King Salmon Airport	Chinitna Bay	Crescent Lake	Port Alsworth	Silver Salmon Creek	Upper Twin Lakes
6/23/19			4					
6/24/19			4					
6/25/19			1					
6/26/19		3	1					
6/27/19		3	1					
6/28/19		3	1					
6/29/19		2	1					
6/30/19		2	1					
7/1/19		2	1					
7/2/19		2	1					
7/3/19		2	1					
7/4/19								
7/5/19								1
7/6/19			2			1		1
7/7/19			2			1		1
7/8/19			2			1		1
7/9/19			2			1		1
7/10/19			2			1		1
7/11/19			2			1		
7/12/19			2			1		
7/13/19								
7/14/19			1	1			1	
7/15/19			1	1			1	
7/16/19			1	1			1	
7/17/19			1	1			1	
7/18/19			1	1			1	
7/19/19			1	1			1	
7/20/19			1					
7/21/19						2		
7/22/19								
7/23/19			1		2			
7/24/19			1		2			
7/25/19			1		2			
7/26/19			1		2			
7/27/19			1		2			
7/28/19			1		2			
7/29/19								
7/30/19								
7/31/19								
8/1/19			1					
8/2/19	2		1					
8/3/19	2		1					
8/4/19	2		1					
8/5/19	2		1					
8/6/19	2		1					
8/7/19	2		1					
8/8/19	2		1					
8/9/19	2		1					
8/10/19			1					
Total research assistant-sampling days	**16**	**19**	**55**	**6**	**12**	**9**	**6**	**6**

In KATM, researchers were on-site at two locations: Crosswinds Lake and Hallo Bay. Two researchers were present at Crosswinds Lake for 8 days. Crosswinds Lake is situated near the confluence of Moraine and Funnel Creeks, where most visitors head shortly after landing on the lake. Intercepts typically occurred soon after planes had landed on Crosswinds Lake. Three main types of visitor groups were observed: pack rafters, stationary anglers, and bear viewers. Occasionally intercepts occurred on the path towards the confluence or at the small body of water in-between Crosswinds Lake and the confluence.

At Hallo Bay, 3 researchers were present for 3 days and 2 researchers were present for 5 additional days. Researchers intercepted visitors primarily on the north beach. The shore of Hallo Bay is primarily oriented north-south and is bisected by Middle Creek. Day-use visitors typically land on the beach, engage in a bear safety orientation, and then proceed to another part of Hallo Bay. Visitors also resided overnight on boats docked offshore, coming to land for scattered periods of time throughout the day. Most commonly, visitors were intercepted upon arrival and solicited for an online questionnaire, however, some visitor groups were approached upon departure if needed.

In LACL, researchers were on-site at five locations. One researcher was present at Chinitna Bay for 6 days. Use in this area came from both day users and overnight visitors. Day-use visitors would typically fly in during the morning and would either be guided directly by their pilots or would check into the lodge for a guided tour. For pilot guided tours, visitors would spot bears from the air, land nearby, and would exit the aircraft to get a closer look. If no bears were spotted on the beach, visitors were ushered to one of three park-specified viewing areas along the beach and wait in hopes of a bear coming out of the brush. For lodge guided tours, visitors would board a bus from the lodge, which took them to the designated viewing areas. On most days, the lodge would also have an afternoon tour as well, repeating their route from the morning, tide depending. The camp, however, hosted a majority of the overnight visitors, taking them to park as well as private viewing areas throughout the day. Visitor intercepts primarily occurred on the bus from the lodge, but some occasions required intercepts on the beach or at one of the park-specified bear viewing areas.

Two researchers were present at Crescent Lake for 6 days. There is one beach location where visitors arrive via aircraft and move throughout Crescent Lake on watercraft. There were two main types of day-use groups, anglers and bear viewers. The angling groups generally arrive on the beach location, spend a notable amount of time fishing downriver, and conclude their trip by returning to the beach location to depart Crescent Lake. Additionally, the researchers intercepted visitors at a lodge on-site during mealtimes, or in the case of day bear viewers, during refreshments after they concluded their experience.

In Port Alsworth, 1 researcher was present for 7 days and 2 were present for an additional day. Port Alsworth is an Alaskan community located within the boundary of LACL, and while a destination for some, it often serves as a gateway location to access KATM, LACL, and other remote Alaskan sites. Transportation into Port Alsworth relies heavily on the use of either float or wheeled planes. During their time in Port Alsworth, visitors to the National Park Service locations frequent the Visitor Center adjacent to LACL headquarters and one of two runways and

spend a range of time observing the exhibits and immersing themselves in the educational information. Afterward, visitors participate in many prominent activities including hiking along trails adjacent to Port Alsworth and within LACL, photography, backcountry camping, and backcountry hiking. Due to the typical level of visitor traffic, the Visitor Center was selected as the primary intercept location for this site.

One researcher was present at Silver Salmon Creek for 6 days. There are two main beach areas where visitors arrive in Silver Salmon Creek, bisected by a creek. Day-use visitors arrive on one of these beaches and recreate throughout the area. The ability for planes to land and take off on these beaches is also tidally influenced, leading to a restricted spatiotemporal window of visitor activity. Additionally, the bisecting creek is tidally influenced, which restricts the ability for researchers to cross during certain times. Furthermore, day-users typically spent less than 20 minutes at the site before taking off. The length of the beach and the limited window during which planes arrive and leave make intercepts on foot challenging, so when possible, the researcher joined an NPS ranger during ATV roving patrol. When not possible, the researcher remained in an area of the beach where planes land most often. Intercepts typically occurred at the end of the visitor experience on the way back to the plane. Additionally, two lodges operate in Silver Salmon Creek, serving overnight visitors who engage in activities such as bear viewing and fishing. Bear viewing through the lodges is unique in that guides drive ATVs along designated trails, towing trailers of typically 6 guests around the site. By request of the lodge owners, these visitors were intercepted on the premises of one of the lodges. Intercepts mainly occurred during an indoor pre-dinner social hour and occasionally in common areas between cabins.

At Upper Twin Lakes/Proenneke’s Cabin, one researcher was present for 6 days. The researcher distributed surveys at the cabin site, where NPS rangers provide a guided tour. When visitors arrived at the cabin, the ranger met them on the beach where planes land or boats dock, during which time the researcher conducted visitor intercepts. Additionally, the NPS rangers monitor a campsite about half a mile away from the cabin. When visitors were present at the campsite, the researcher intercepted them there.

NOTE

It is important to note that July 2019 produced the lowest LACL beach bear count (32) since 2005 (27). Of those bears, zero were seen at Silver Salmon Creek, almost eliminating day-use traffic at this location during the data collection period. At Chinitna Bay, it forced much of the day-use to shift from NPS land to an area called Clam Bay. Clam Bay is a spot for clamming bears and during the data collection period, was the only place within Chinitna Bay where bears were highly concentrated. However, this site exists on land owned by the state of Alaska, meaning those visitors were not NPS visitors and therefore, were not be intercepted. As a result, the vast majority of visitors intercepted at this location were either staying at the camp or participating in guided tours through the lodge.

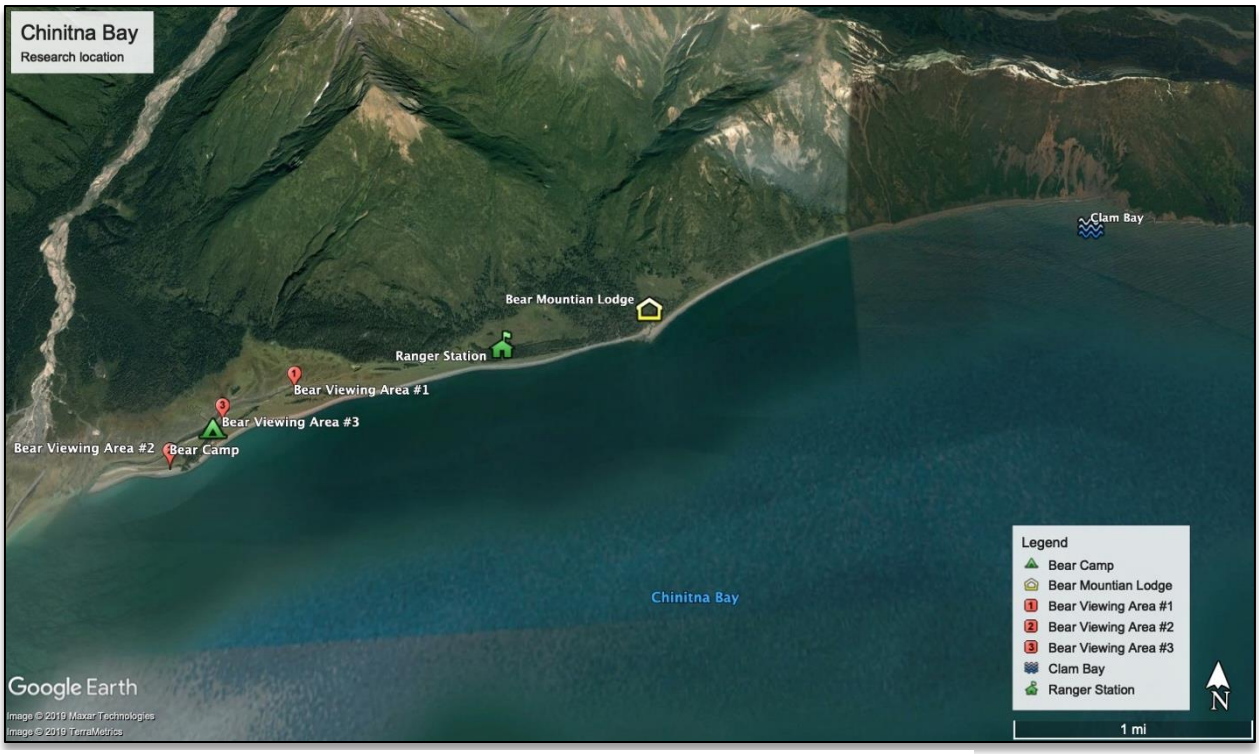


Figure 11. Map of viewing locations throughout the Chinitna Bay sampling site

King Salmon Airport intercepts occurred in the terminal/gate area. The airport is very small, and researchers were able to monitor the entire waiting area and approach most flyers. Travelers were thoroughly screened to assess whether: (a) they visited either KATM or LACL and (b) they visited someplace other than Brooks Camp, i.e. a backcountry or wilderness area.

During regional travel corridor intercepts, researchers approached travelers at random and asked a series of qualifying questions to determine whether the person visited KATM or LACL:

1) Have you visited either KATM or LACL within the last 30 days?

    a. If no → are you planning to visit either destination during your visit?

    b. If yes → did you (or are you planning to) visit an area other than Brooks Camp?

The question regarding Brooks Camp was often used because Brooks Camp is the only area of either park not included in this study. Brooks Camp was typically a name that participants recognized and was a useful and straightforward way to identify individuals who had visited backcountry or wilderness areas.

In some cases, these qualifying questions were clear to respondents. Other times, people could not answer these questions either because they did not know the names of the locations they visited, or they could not remember (see results regarding locations and activities for more). In these cases, researchers would attempt to identify whether the individual visited an area in either

KATM or LACL by displaying a map or asking alternative questions regarding the place they visited, activities they engaged in, or infrastructure present. For example, researchers may have asked whether the place had bear viewing platforms and a visitor center, which are only present in Brooks Camp. A common area of confusion for visitors was the Valley of Ten Thousand Smokes, which qualifies as a backcountry or wilderness site. While many access the Valley of Ten Thousand Smokes through Brooks Camp and do not travel elsewhere in either park, they are still eligible to take the survey.

Ultimately, those that had visited backcountry or wilderness areas within either or both parks in the past 30 days as well as those who planned to visit these areas on their current trip, were asked to take a business card and provide an email address for online survey completion.

INITIAL RESULTS

Visitor Demographics • **Visitor-Reported Locations** • **Past Use History** • **Crowding Experienced**

Initial Results

Combined Visitor Demographics

During sampling, 1,123 business cards were distributed to visitors across the eight sampling sites. After sending almost 3,500 reminder emails, we received 735 responses resulting in a response rate of approximately 65.4% and a 2.89% confidence interval (C.I.) at the 95% confidence level. When response rates are segmented by intercept location, 52 of 88 (62.5%) visitors intercepted at Chinitna Bay, 67 of 111 (60.4%) at Crescent Lake, 153 of 234 (65.4%) at Crosswinds Lake, 136 of 211 (64.5%) at Hallo Bay, 192 of 315 (61.0%) at the King Salmon Airport, 55 of 74 (74.3%) at Port Alsworth, 31 of 48 (64.6%) at Silver Salmon Creek, and 9 of 13 (69.2%) at Upper Twin Lakes completed the survey.

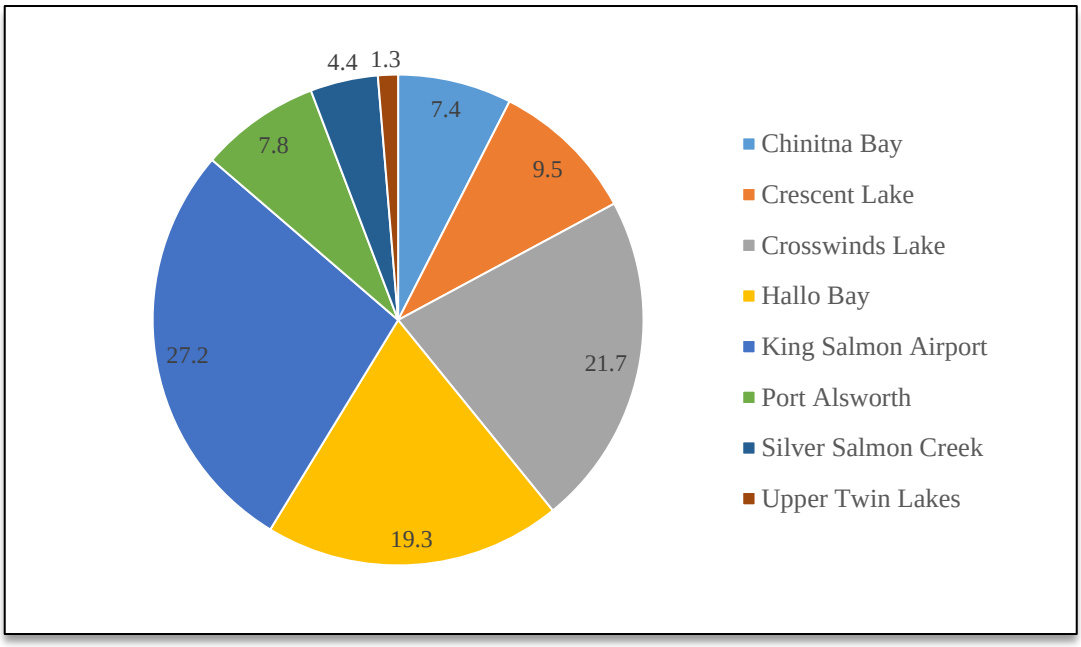


Figure 12. Percent of total responses associated with each intercept location

The selection of sampling locations and timing allowed the researchers to intercept visitors of many different activity types. Across both parks, bear viewing was the most reported primary activity (49.4% overall), followed by angling (26.1% overall). Bear viewing was the most common activity among visitors to Chinitna Bay, Hallo Bay, and Silver Salmon Creek, while angling was the most common activity among visitors to Crescent Lake, Crosswinds Lake, and Upper Twin Lakes. The next most popular activities across all sites were photography (6.5% overall) and other (8.8% overall). When asked to specify 'other' activities, write-in responses included visiting Dick Proenneke's cabin at Twin Lakes, park collecting, rafting, learning about or visiting the Valley of Ten Thousand Smokes, and relaxation. The sampling stratification procedures, intercept protocols, high response rate across sites, and low confidence interval suggest that the resulting sample is robust and appropriately represents the visiting populations of KATM and LACL.

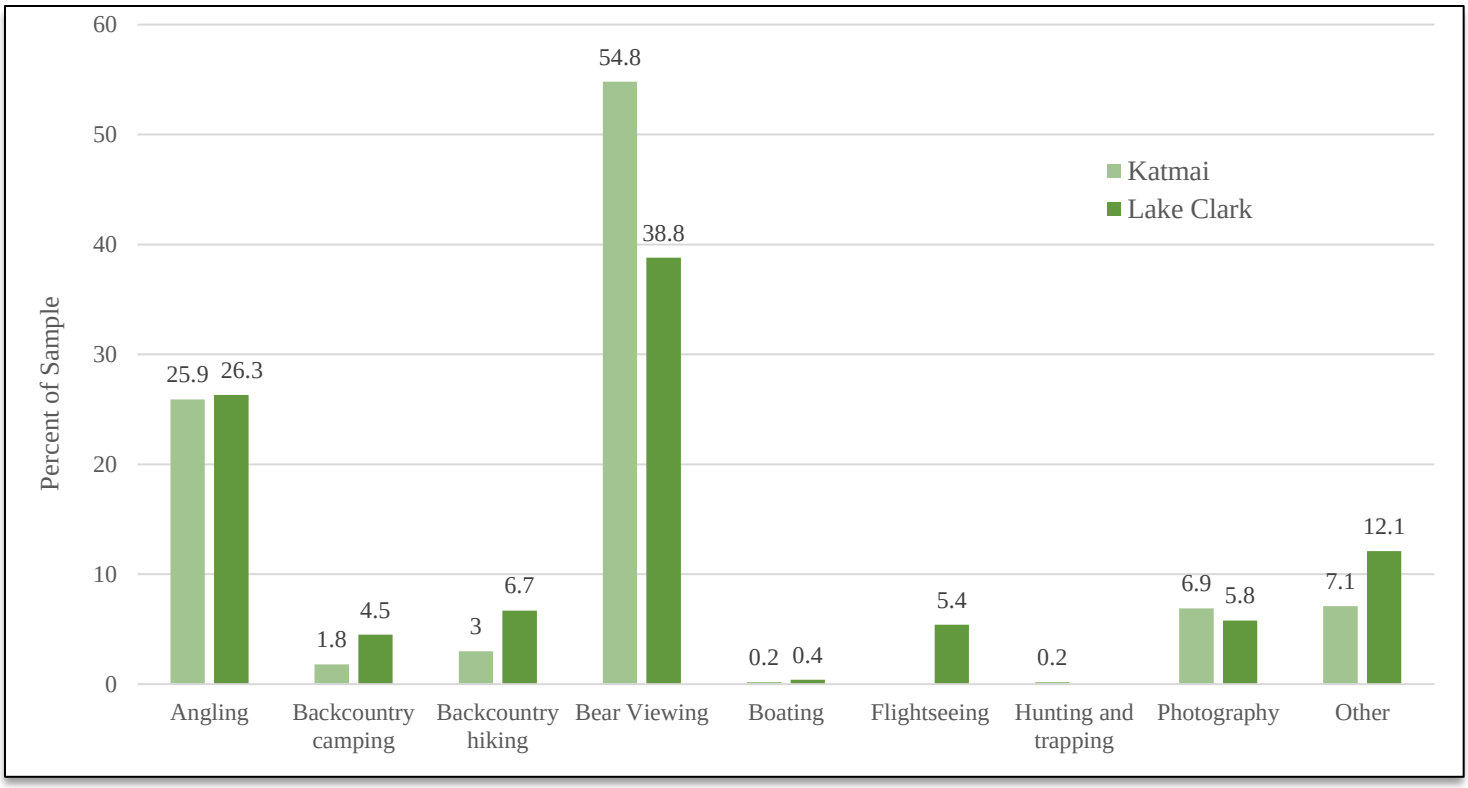


Figure 13. Proportion of respondents selecting each activity as the primary activity during their 2019 visit.

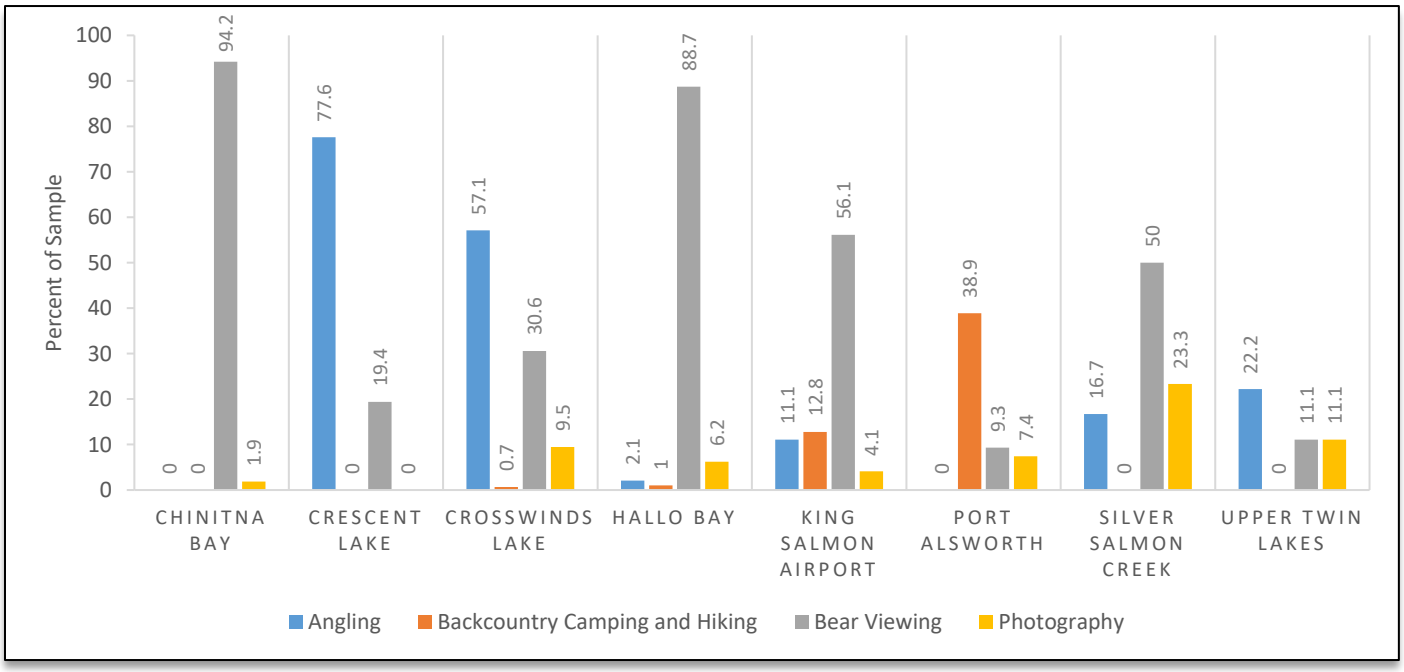


Figure 14. Main activity type reported by respondents intercepted at various locations in KATM and LACL in 2019.

Visitors to KATM and LACL reported an average age of 53.5 with 59.9% of respondents identifying as male, 40.0% identifying as female, and 0.1% declaring 'other.' The average age of respondents was fairly consistent, with no intercept location showing averages lower than 52 or higher than 59. Variation around these means is large so interpretation is limited, but visitors to Hallo Bay and Chinitna Bay tended to be slightly younger than the average, and visitors to Upper Twin Lakes, Silver Salmon Creek, and Crosswinds Lake tended to be slightly older than the average. Gender distribution was approximately equal across all intercept sites, with Crosswinds Lake and Crescent Lake showing slightly higher percentages of males, potentially due to more sport fishing at each site.

While education level varied across the sample, a large portion of respondents (43.2%) chose graduate or professional degree as the highest level of education received. The next most common choices were four-year college graduate (32.2%) and high school graduate (7.9%), with 2.8% choosing not to answer. Visitors intercepted at Crescent Lake were the most diverse, with 38.7% receiving less than a four-year college degree. Visitors to Hallo Bay were the second most diverse, with 27% receiving less than a four-year college degree, followed by Chinitna Bay (22.9%) and Silver Salmon Creek (20.6%).

Visitors also had varying levels of household income, with most choosing the following three levels: $200,000 or more (25.9%), $100,000 to $149,999 (17.3%), and $150,000 to $199,999 (11.6%), with an additional 19.3% preferring not to answer. Chinitna Bay, Crescent Lake, and Hallo Bay all show relatively high levels of diversity, with 27.7%, 28.7%, and 28.0%, respectively, earning less than $100,000 per year. Visitors intercepted at Upper Twin Lakes were the most economically diverse with 44.4%, while visitors intercepted at Crosswinds Lake were the least economically diverse, with 17.1% earning less than $100,000. Income and education levels of KATM and LACL visitors are both well-beyond the national average (approximately 35% of U.S. residents report possessing a bachelor's degree or higher with a median household income of approximately $59,000; USCB, 2020).

Lastly, in terms of race or ethnicity, a large majority of respondents self-identified as white (75.3%), while 2.5% identified as Asian, 5.7% declined to answer, and the remaining self-identified as other races. Distributions were highly similar across intercept locations. Hallo Bay received the widest range of race or ethnicity, but none other than white was larger than 3.7%. The proportion of respondents declining to answer was higher at Silver Salmon Creek (12.9%) than elsewhere but was similar across Crescent Lake, Crosswinds Lake, and Hallo Bay (7.5%, 7.2%, and 7.4%, respectively).

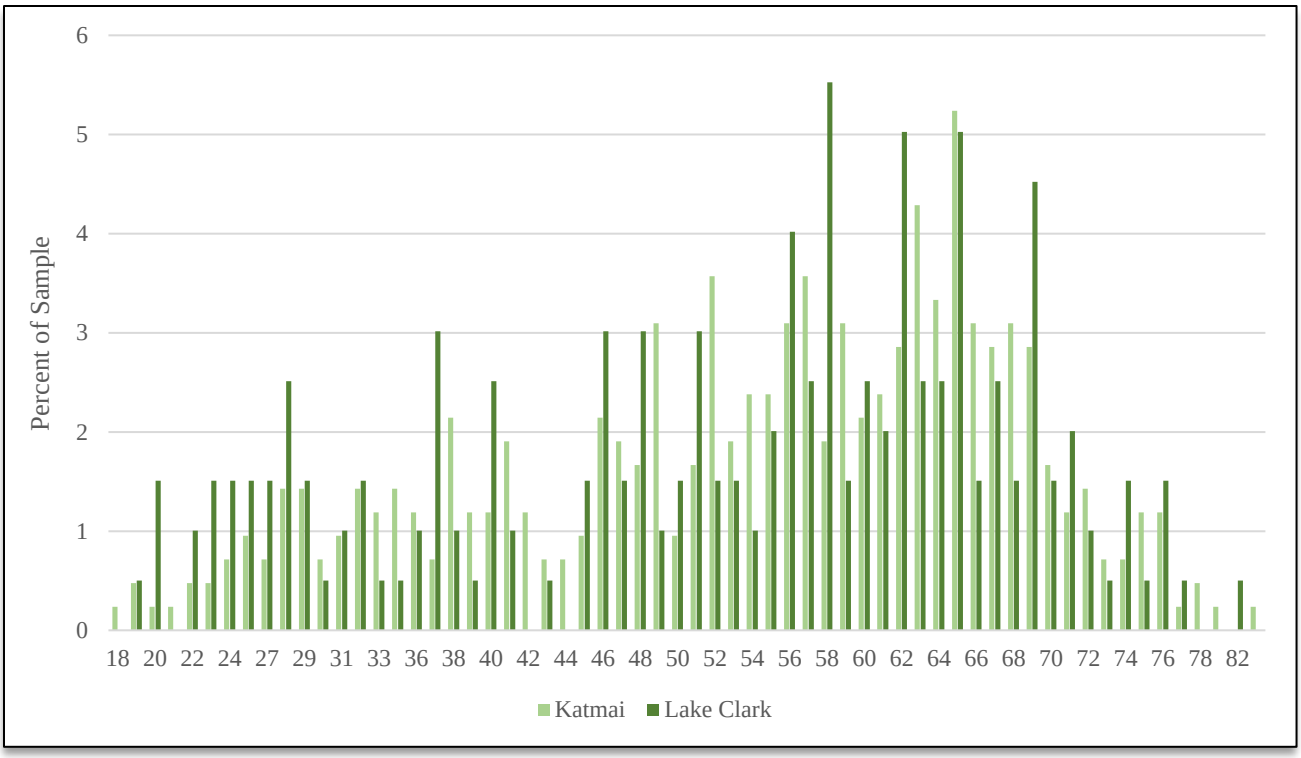


Figure 15. Age distribution of surveyed visitors to KATM and LACL in 2019.

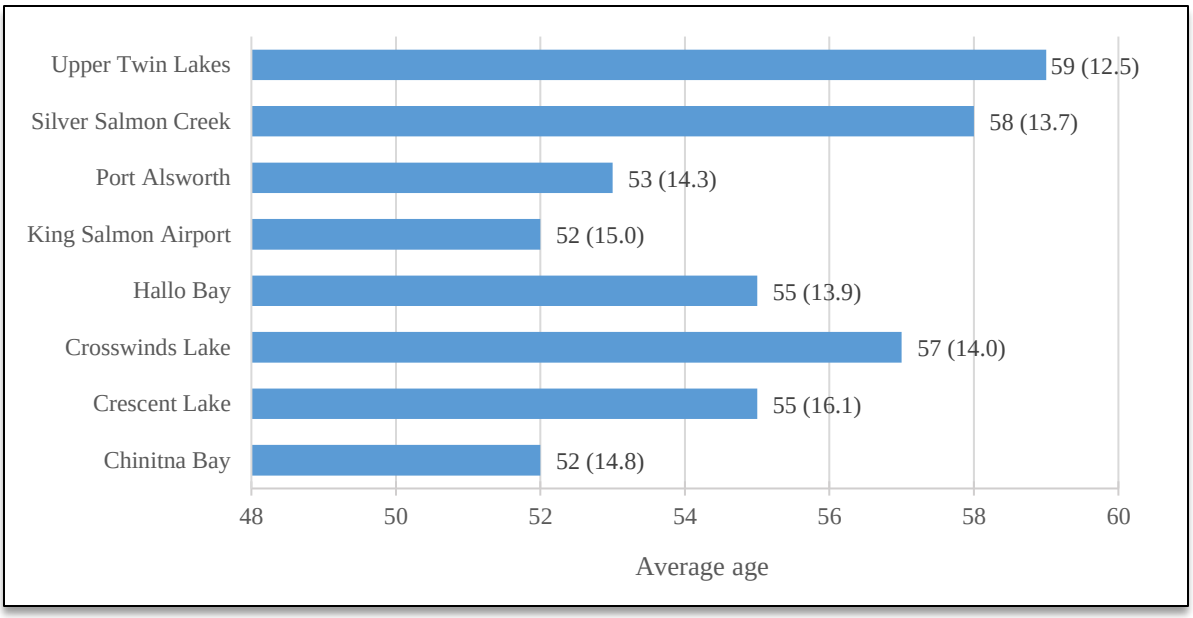


Figure 16. Average age of respondents by intercept location. Data labels represent mean (SD) values.

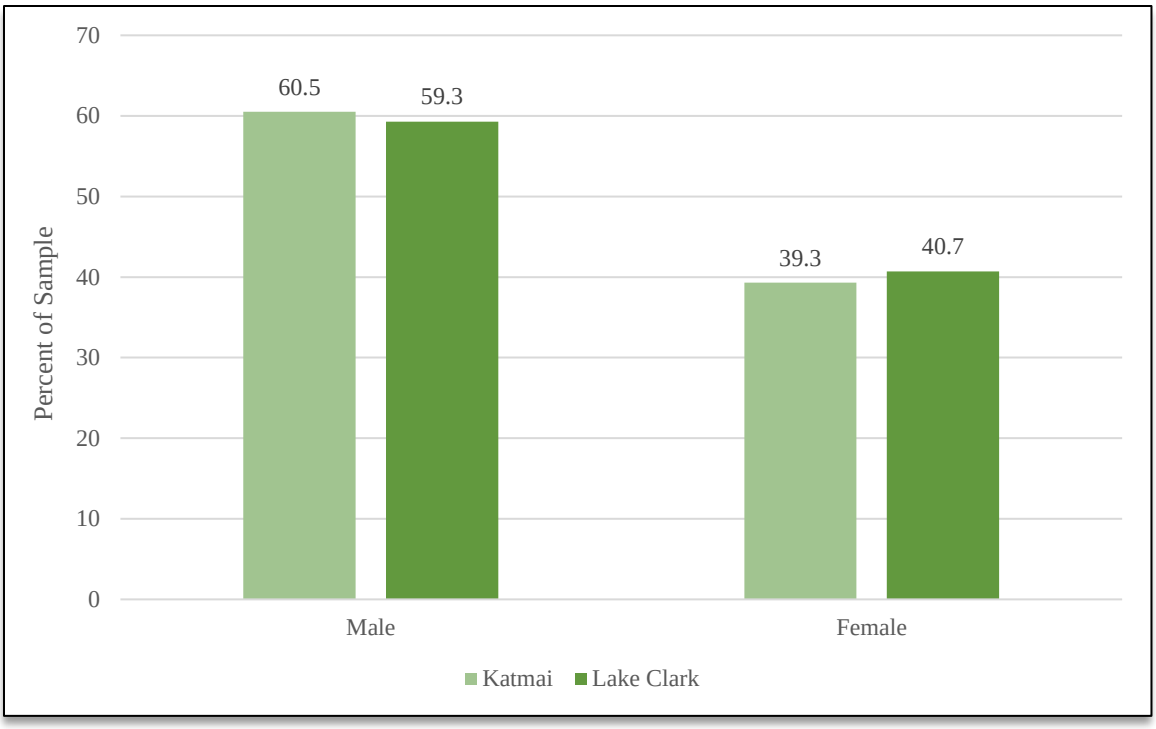


Figure 17. Gender orientation of surveyed visitors to KATM and LACL in 2019.

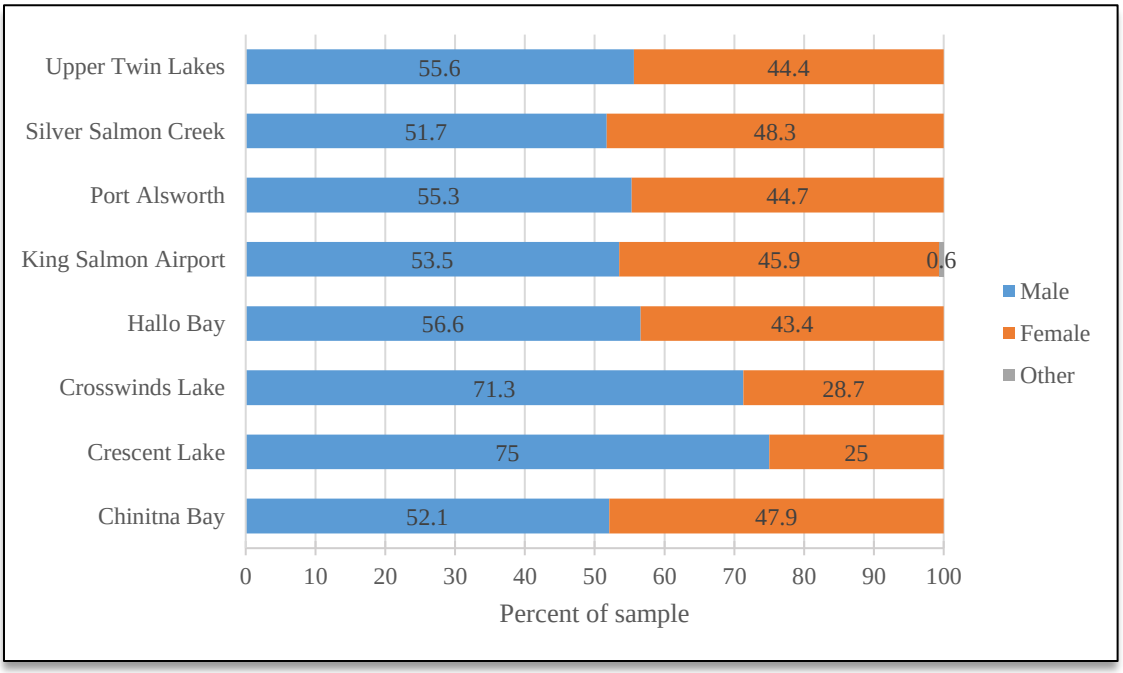


Figure 18. Percent of respondents selecting each answer choice in regard to their gender identification, by intercept location.

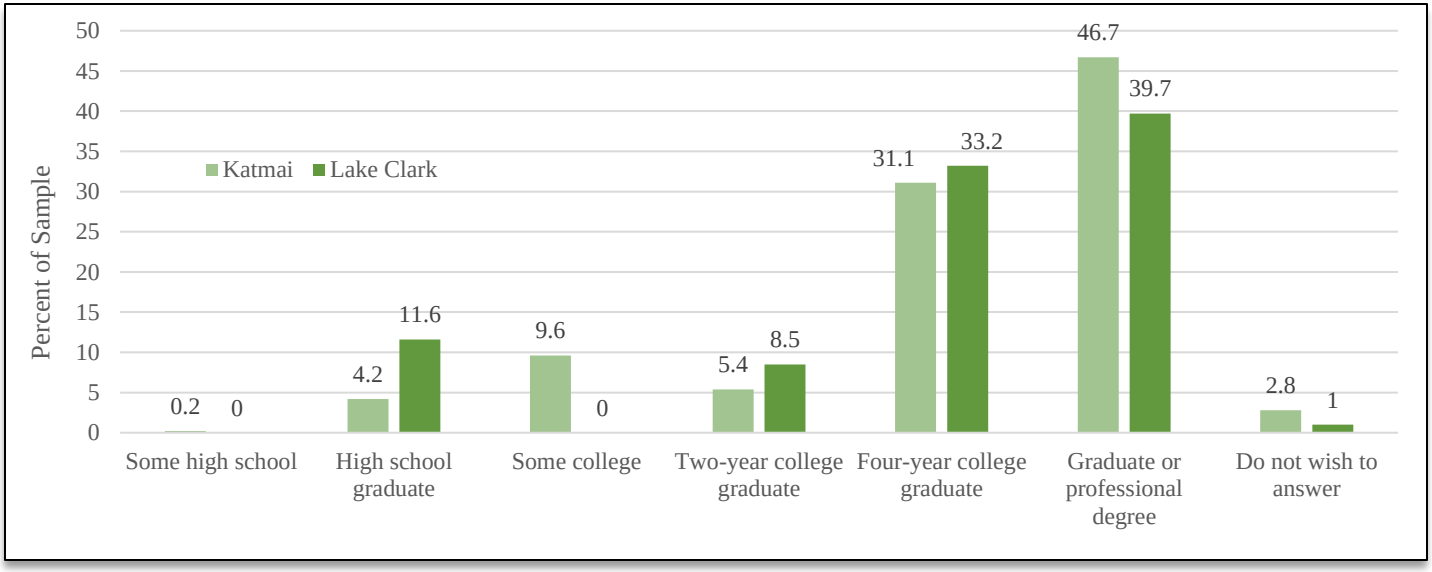


Figure 19. Highest level of education earned by surveyed visitors to KATM and LACL in 2019.

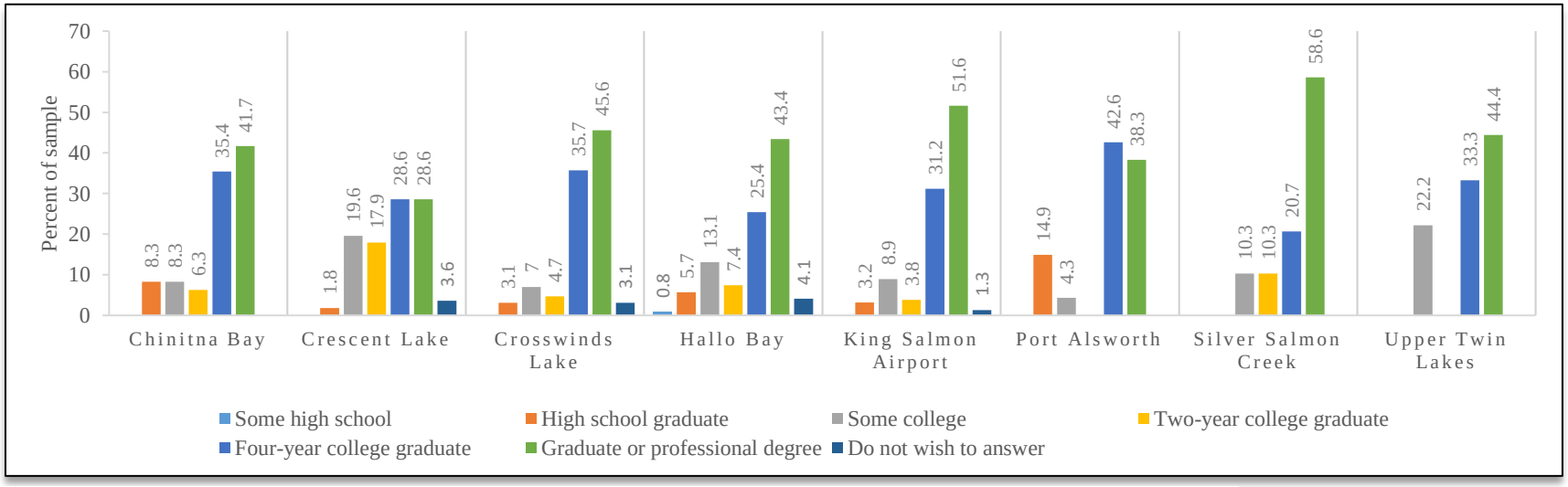


Figure 20. Highest level of education earned among surveyed visitors to different intercept locations.

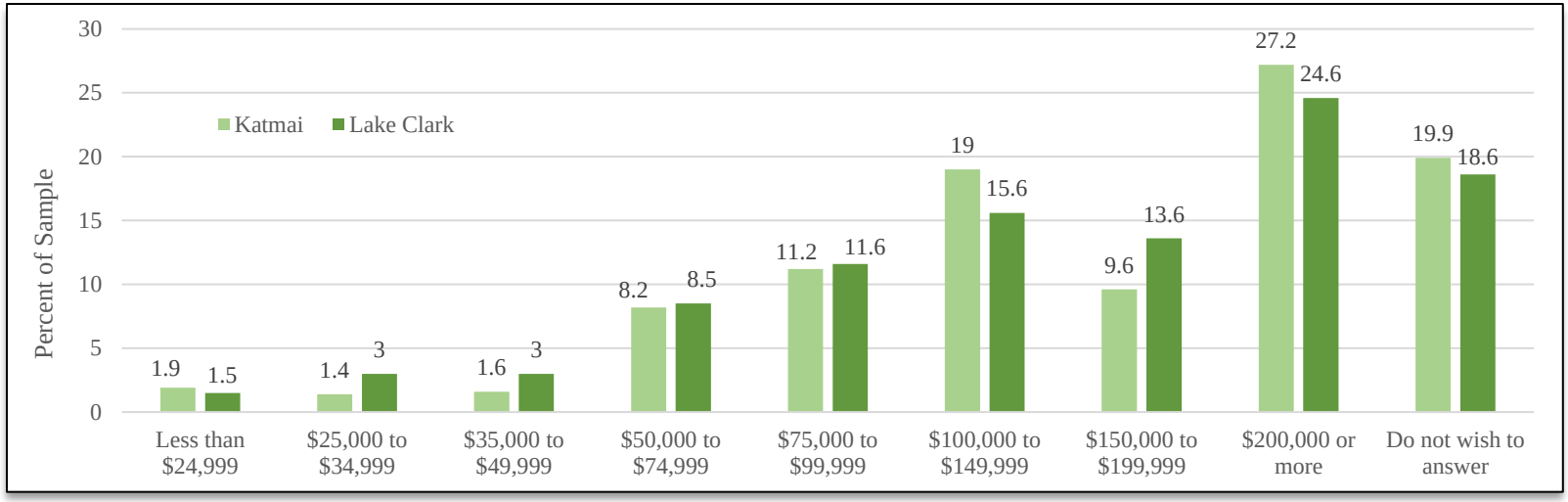


Figure 21. Annual household income reported by surveyed visitors to KATM and LACL in 2019.

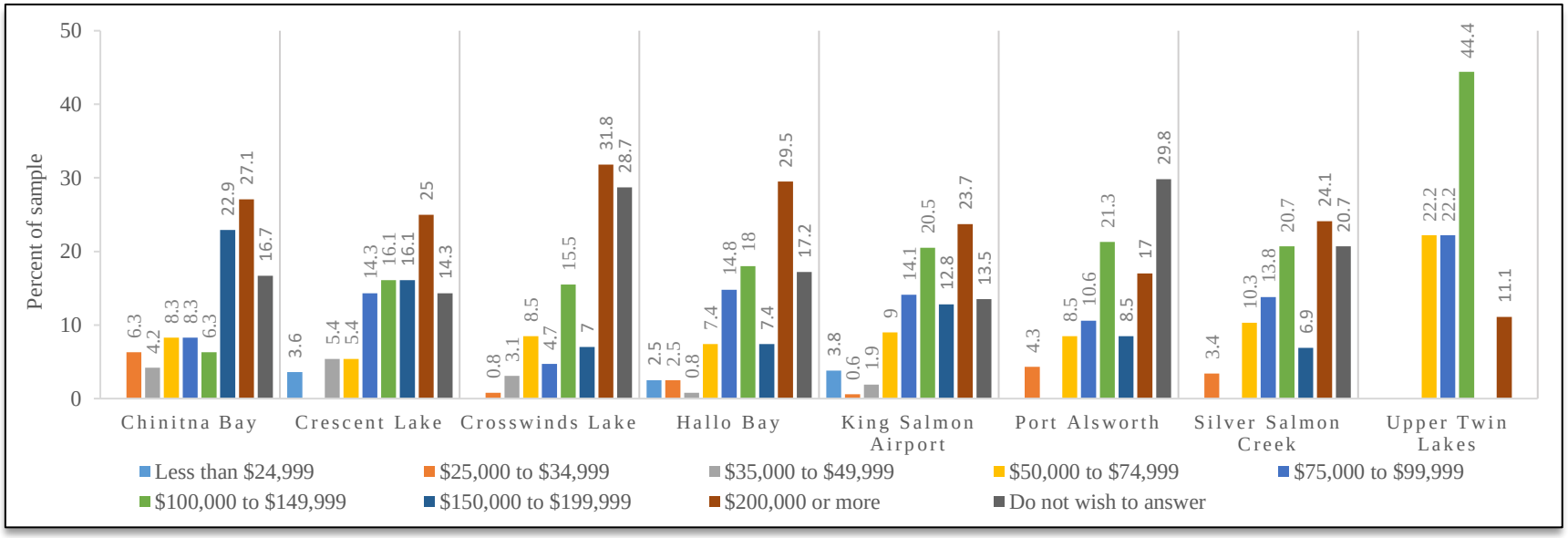


Figure 22. Distribution of annual household income level among visitors to different intercept locations.

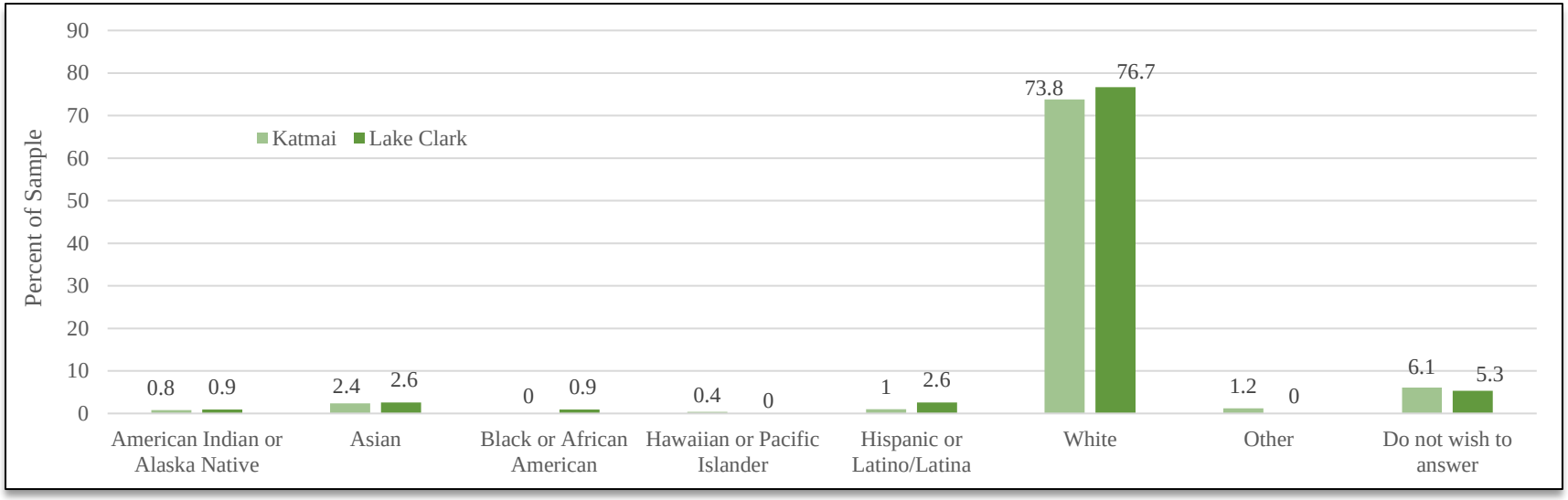


Figure 23. Self-identified race or ethnicity reported by surveyed visitors to KATM and LACL in 2019.

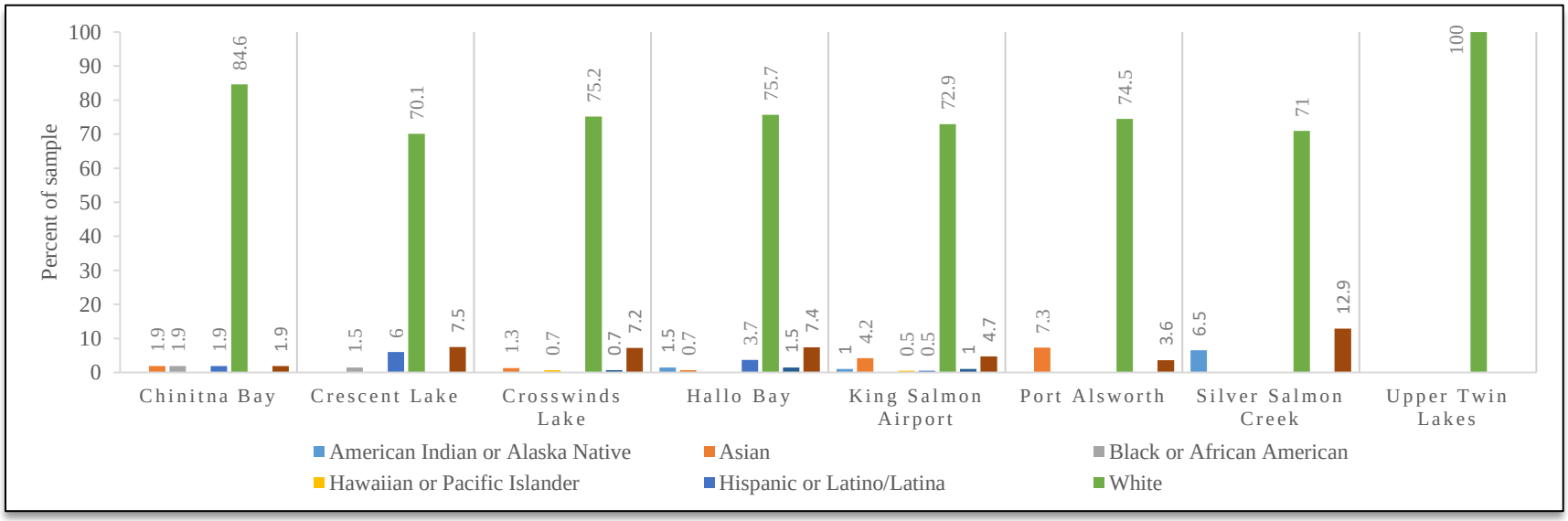


Figure 24. Distribution of race and ethnicity among visitors to different intercept locations.

Home Locations of KATM Visitors

While California (11.3%), Alaska (10.6%), and Colorado (8.3%) were the most common states from which visitors came, KATM draws visitors from all over the United States (Figure 25, Table 2). The next most common states were Texas (6.4%) and Florida (4.7%). International visitors make up a large portion of the visitation to KATM as well (Figure 25, Table 3). Visitors from the United Kingdom comprised 4.0% of the sample, with an additional 8.5% comprised of visitors from Argentina, Australia, Bulgaria, Canada, Columbia, Cyprus, the Czech Republic, France, Hungary, Latvia, Lithuania, the Netherlands, Norway, South Africa, and Switzerland.

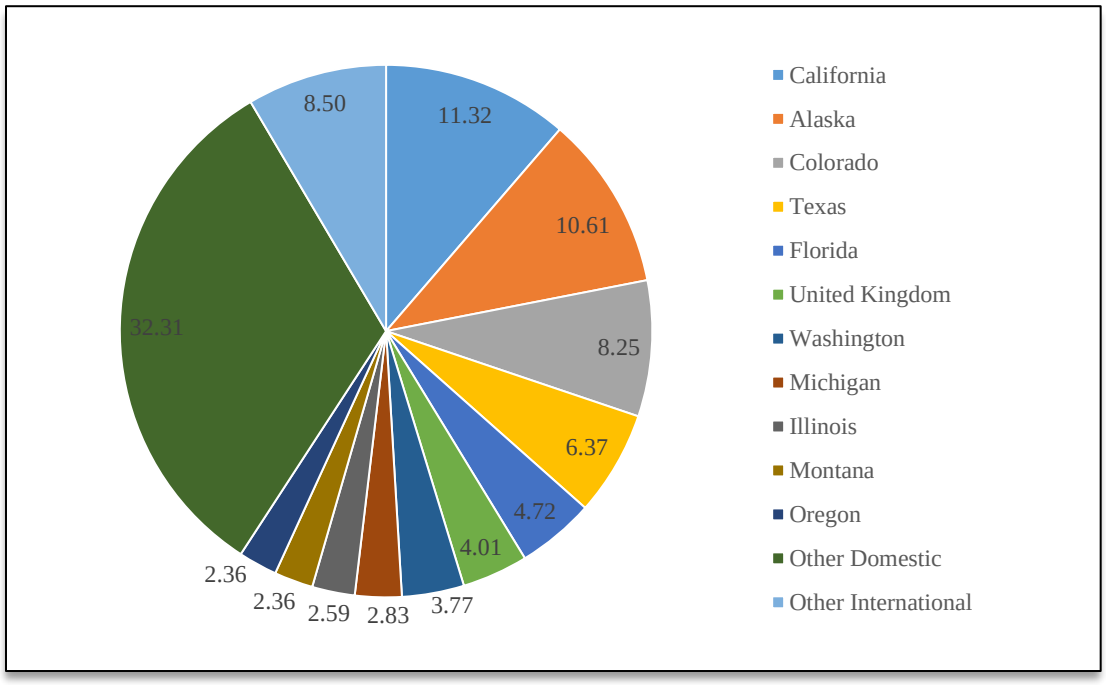


Figure 25. Summary of 2019 KATM survey respondents home locations

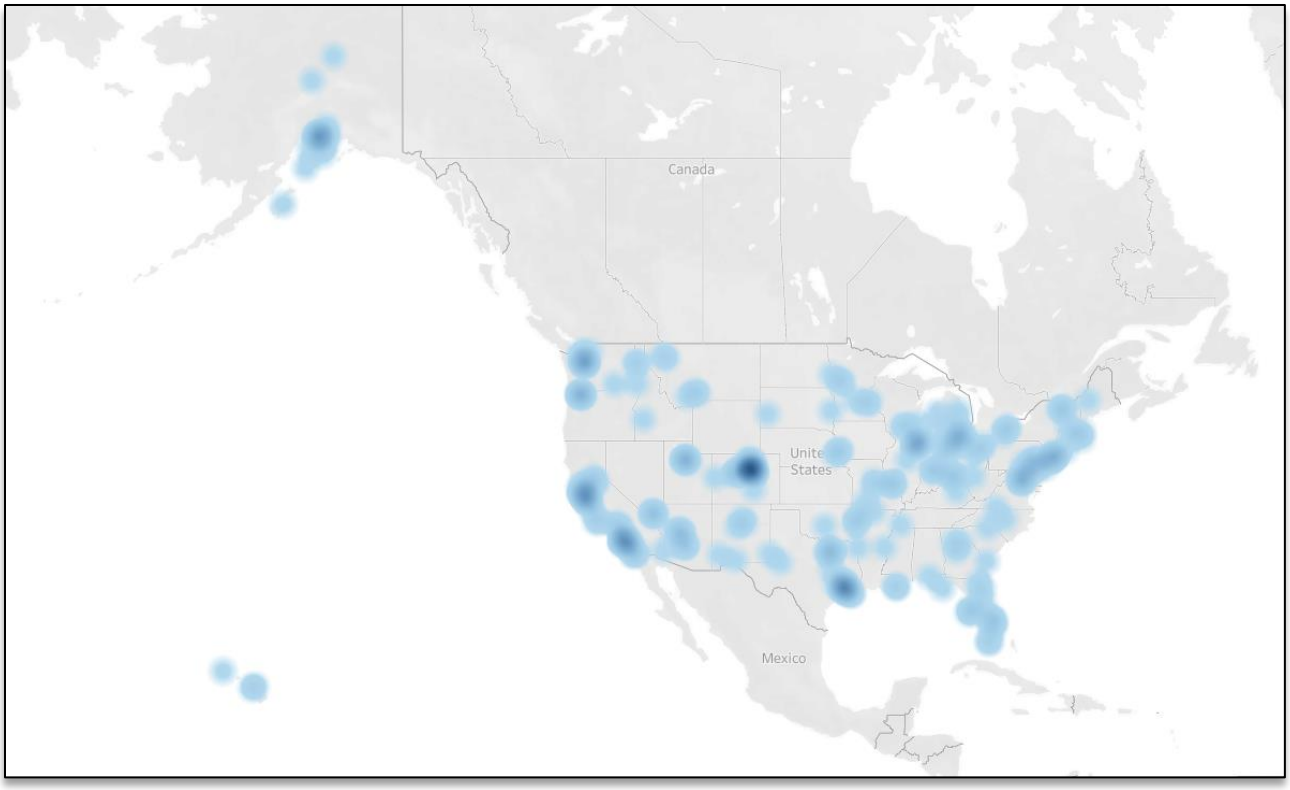


Figure 26. Map of United States zip codes reported by KATM visitors. Darker blue represents higher frequencies.

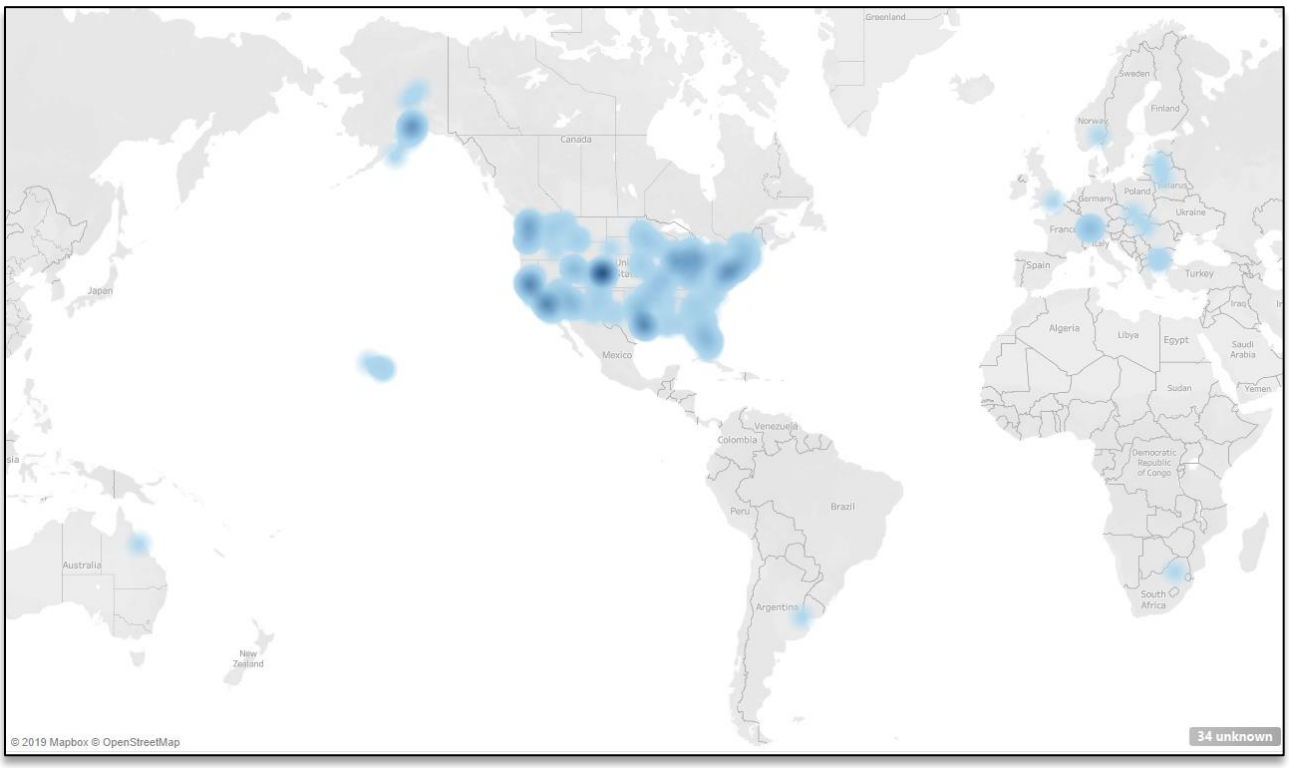


Figure 27. Map of all zip codes reported by KATM visitors. Darker blue represents higher frequencies.

Table 2. *Proportion of KATM visitors from each state*

State	Count	Percent	State	Count	Percent
CA	48	11.3	MD	4	0.9
AK	45	10.6	NC	4	0.9
CO	35	8.3	NE	4	0.9
TX	27	6.4	NV	4	0.9
FL	20	4.7	VA	4	0.9
WA	16	3.8	VT	4	0.9
MI	12	2.8	WI	4	0.9
IL	11	2.6	HI	3	0.7
MT	10	2.4	LA	3	0.7
OR	10	2.4	CT	2	0.5
MO	9	2.1	DE	2	0.5
NY	9	2.1	NH	2	0.5
AZ	8	1.9	NJ	2	0.5
IN	8	1.9	SC	2	0.5
OH	8	1.9	SD	2	0.5
UT	8	1.9	DC	1	0.2
NM	7	1.7	KY	1	0.2
PA	6	1.4	ME	1	0.2
AR	5	1.2	ND	1	0.2
MN	5	1.2	OK	1	0.2
GA	4	0.9	TN	1	0.2
ID	4	0.9	International	53	12.5
MA	4	0.9	TOTAL	424	100

Table 3. *Proportion of KATM international visitors from each country*

Country	Count	Percent	Country	Count	Percent
United Kingdom	17	4.0	Cyprus	1	0.2
Netherlands	8	1.9	Czech Republic	1	0.2
Canada	7	1.7	France	1	0.2
Switzerland	6	1.4	Hungary	1	0.2
Australia	2	0.5	Latvia	1	0.2
Bulgaria	2	0.5	Lithuania	1	0.2
Norway	2	0.5	South Africa	1	0.2
Argentina	1	0.2	Domestic	371	0.875
Columbia	1	0.2	TOTAL	424	100

Home Locations of LACL Visitors

While California (13.1%), Alaska (8.6%), and Colorado (6.6%) were the most common states from which visitors came, LACL draws visitors from all over the United States (Figure 28, Table 4). The next most common states were Georgia (4.0%) and Texas (4.0%). International visitors make up a significant portion (6.1%) of the visitation to LACL as well (Figure 28, Table 5). Countries reported include the United Kingdom, Hungary, Switzerland, Australia, Bulgaria, Canada, Ireland, and Romania.

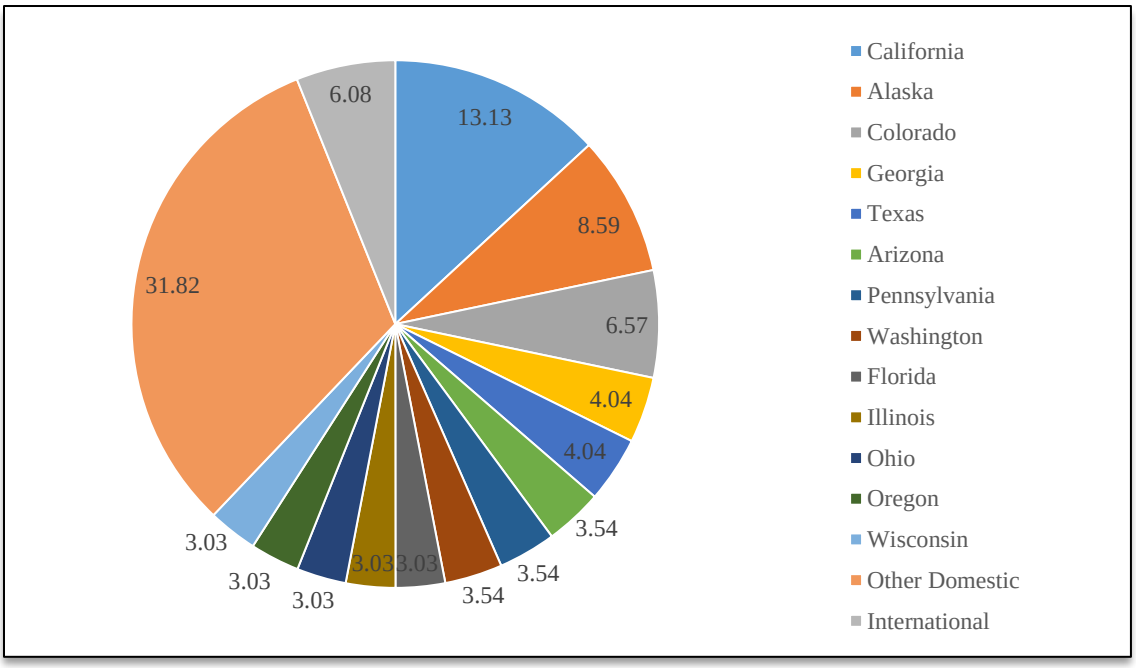


Figure 28. Summary of 2019 LACL survey respondent home locations

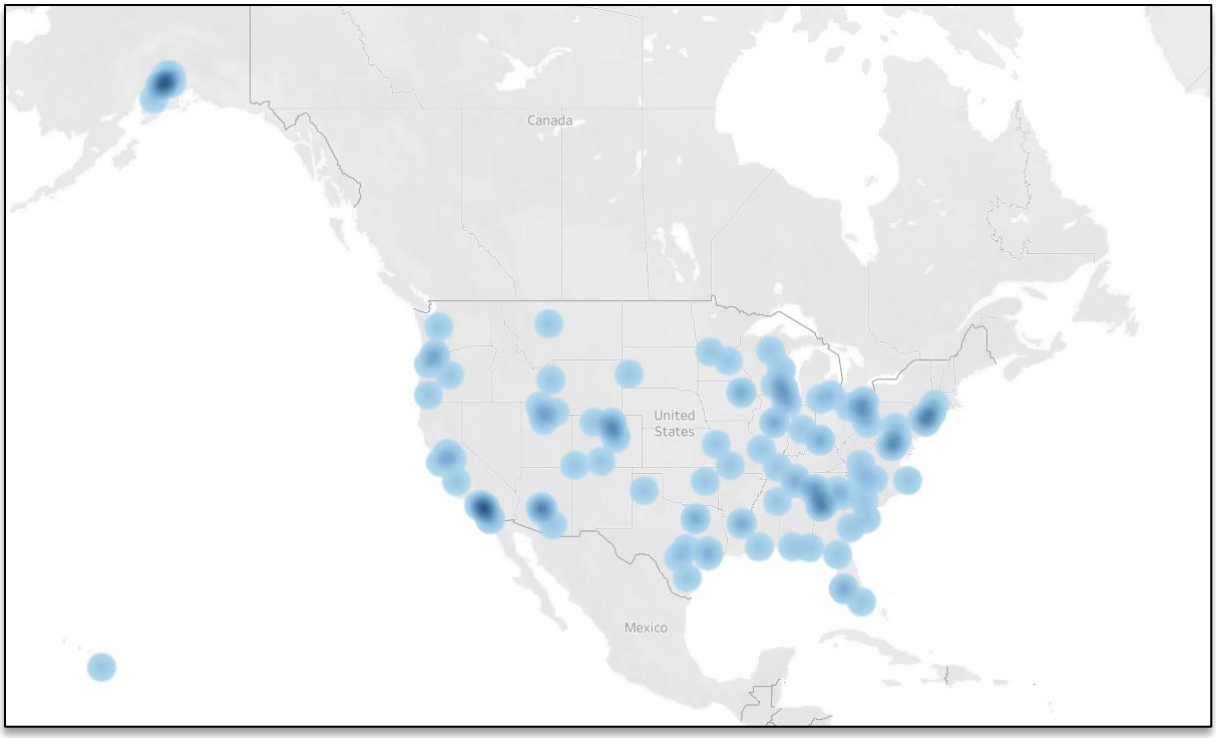


Figure 29. Map of all U.S. zip codes reported by LACL visitors. Darker blue represents higher frequencies.

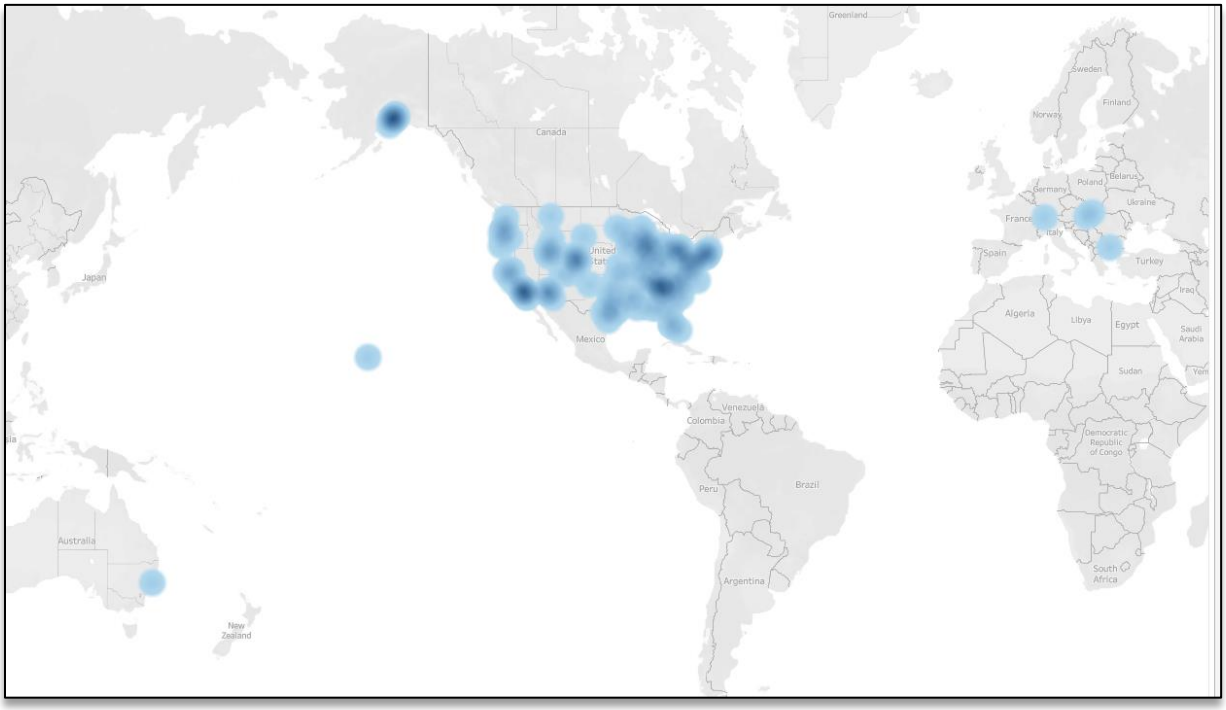


Figure 30. Map of all zip codes reported by LACL visitors. Darker blue represents higher frequencies.

Table 4. *Proportion of LACL visitors from each state*

State	Count	Percent	State	Count	Percent
CA	26	13.1	MD	3	1.5
AK	17	8.6	NY	3	1.5
CO	13	6.6	SC	3	1.5
TX	8	4.0	MN	2	1.0
AZ	8	4.0	NJ	2	1.0
PA	7	3.5	WY	2	1.0
WA	7	3.5	DC	1	0.5
FL	7	3.5	HI	1	0.5
IL	6	3.0	ID	1	0.5
OH	6	3.0	IN	1	0.5
OR	6	3.0	KS	1	0.5
WI	6	3.0	KY	1	0.5
IA	5	2.5	MO	1	0.5
NC	5	2.5	MS	1	0.5
TN	5	2.5	MT	1	0.5
UT	5	2.5	NM	1	0.5
CT	4	2.0	OK	1	0.5
LA	4	2.0	SD	1	0.5
MI	4	2.0	International	12	6.1
VA	4	2.0	TOTAL	198	100

Table 5. *Proportion of LACL international visitors from each country*

Country	Count	Percent
United Kingdom	3	1.5
Hungary	2	1.0
Switzerland	2	1.0
Australia	1	0.5
Bulgaria	1	0.5
Canada	1	0.5
Ireland	1	0.5
Romania	1	0.5
Domestic	186	93.9
TOTAL	198	100

Visitor-Reported Locations

While completing the online survey, respondents were asked to select each location they visited during their trip to KATM or LACL (Appendix D). In KATM, the four most commonly visited locations were: The Valley of Ten Thousand Smokes (40.3%) and Brooks Camp, Crosswinds Lake (28.7%), and Hallo Bay (21.7%). Although visitors who only traveled to Brooks Camp in KATM were not eligible for this survey, those who selected Brooks Camp were eligible as a result of visiting at least one backcountry location, most commonly the Valley of Ten Thousand Smokes. Of those who selected 'other,' specified locations included the Alagnak River (2.3%), Battle River/Lake (1.2%), Kamishak River (1.4%), and Nonvianuk Lake (1.4%). Lastly, 10.7% of respondents reported not knowing where they visited.

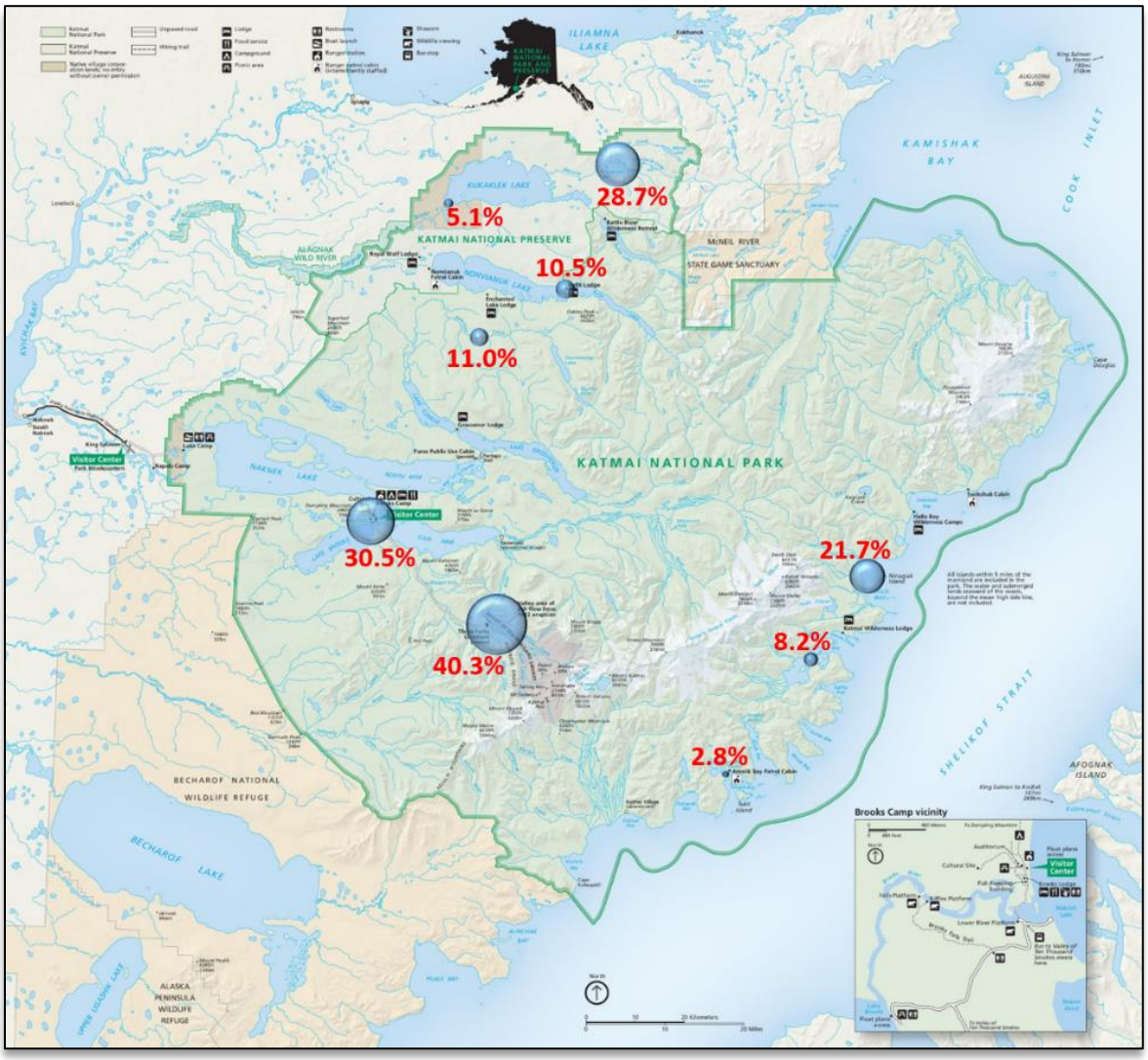


Figure 31. Map of the percent of visitors who reported visiting each site within KATM.

In LACL, the three most commonly visited locations were: Crescent Lake (33.2%), Chinitna Bay (30.9%), and Silver Salmon Creek (20.6%). Of those who selected ‘other,’ specified locations included Port Alsworth (5.8%) and Turquoise Lake (3.1%). Lastly, 3.1% of respondents reported not knowing where they visited.

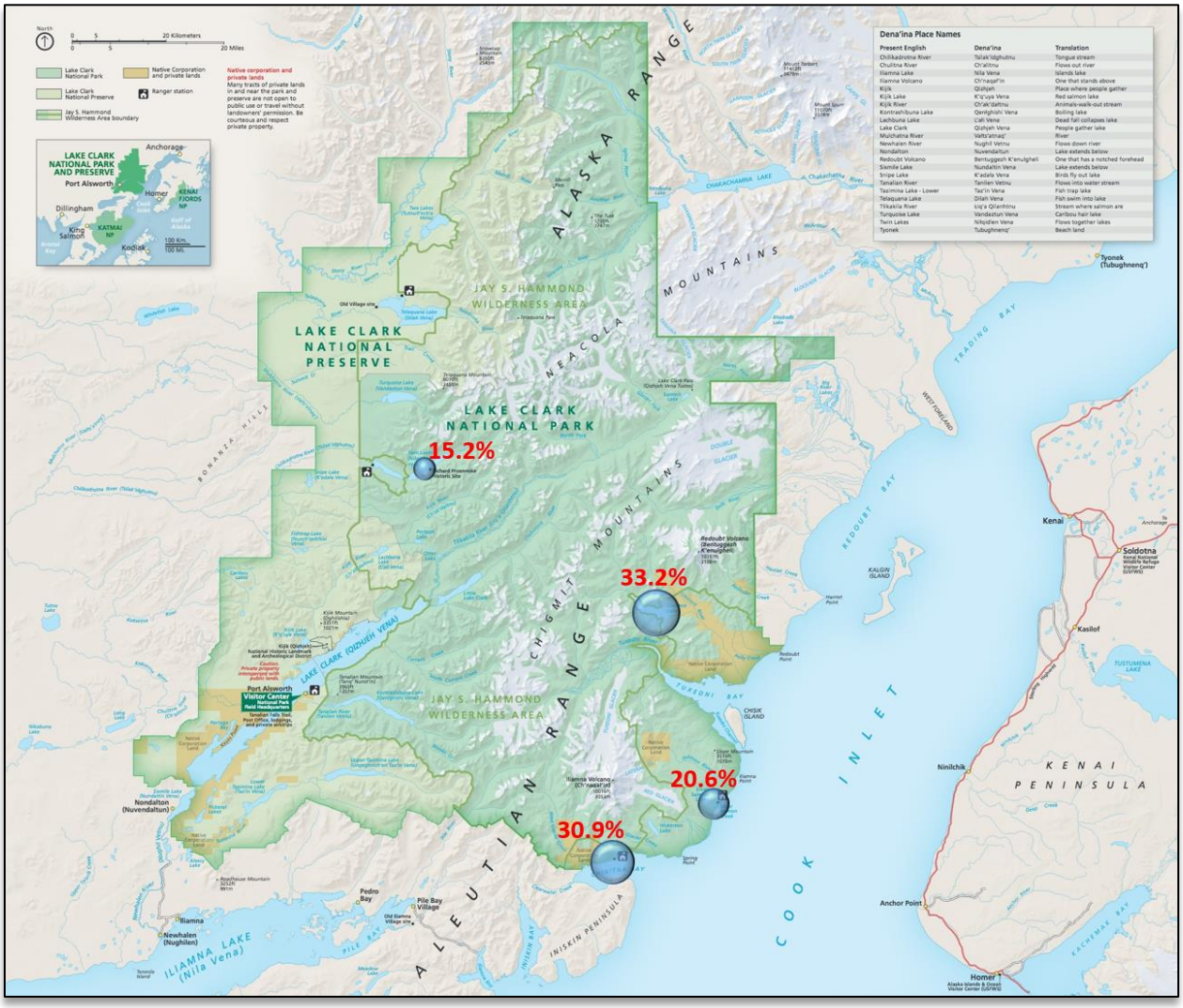


Figure 32. Map of the percent of visitors who reported visiting each site within LACL.

To further assess the representativeness of the sample, the research team compared the frequency of visitor-reported locations with that of CUA-reported trips. The research team summed client counts for all backcountry locations in KATM and LACL (excluding Brooks Camp) from 2007 through 2017. The percent of clients visiting each of the more popular sites was then calculated and compared to visitor reports. Considering the limitations in data collection and intercept locations and potential error in CUA reporting, the survey sample aligns well with the CUA reported visitor distribution throughout the park. Sites at which intercepts occurred were more

prevalent in the visitor-reported locations than in past CUA reports, but sampling at regional travel corridors provided access to otherwise unavailable populations. American Creek, Kukak Bay, Kukaklek Lake, and Turquoise Lake were each slightly overrepresented in our sample despite the lack of intercepts at these locations. While proportions are not identical, the similarities demonstrate representativeness of the survey sample.

Table 6. *Percent of backcountry clients brought to each location by CUAs compared to percent of respondents reporting visits to each location.*

Location	CUA Reported (2007-2017)	Visitor Reported (2019)
KATM		
Alagnak River	8.5%	2.3%
American Creek	4.6%	11.0%
Battle Lake/River	3.2%	1.2%
Moraine/Funnel Creeks	19.9%	28.7%
Geographic Harbor/Amalik Bay	4.1%	2.8%
Hallo Bay	13.4%	21.7%
Kamishak River	4.1%	1.4%
Kukak Bay	2.4%	2.8%
Kukaklek Lake/Outlet	4.1%	5.1%
Kulik Lake/River	13.1%	10.5%
Nonvianuk Lake/Outlet	1.6%	1.4%
LACL		
Chinitna Bay	22.6%	30.9%
Crescent Lake	31.1%	33.2%
Silver Salmon Creek	15.6%	20.6%
Turquoise Lake	1.8%	3.1%
Twin Lakes	8.5%	15.2%

Past Use History

All respondents completed questionnaire sections regarding their history of visitation to KATM or LACL, including their current visit. Several elements go into understanding this past use history (PUH). Specifically, visitors indicated: a) how many days they spent in KATM or LACL during their current visit, b) if they only spent one day, how many hours they spent in KATM or LACL, c) how many days in the last five years (sixty months) they spent in KATM or LACL, and d) how many years (total) they spent visiting KATM or LACL.

For both KATM and LACL, the majority of visitors spent one day in the park during their current trip. Of those who visited for only one day during this trip, the majority spent between 3 and 8 hours in the park. When asked about their visitation in the last five years, approximately 45% of visitors reported spending only one day visiting the park. Approximately 12.2% and 11.6% reported spending two and three days, respectively, and 2.9% reported greater than 25 days over the last five years. 73.4% of surveyed KATM visitors and 77.2% of surveyed LACL visitors were first-time visitors to the park. Overall, visitors to both parks have very similar past use histories, but KATM visitors (M = 6.51 hours, SD = 4.1) tend to spend more time in the park on day trips than do LACL visitors (M = 5.33 hours, SD = 2.5).

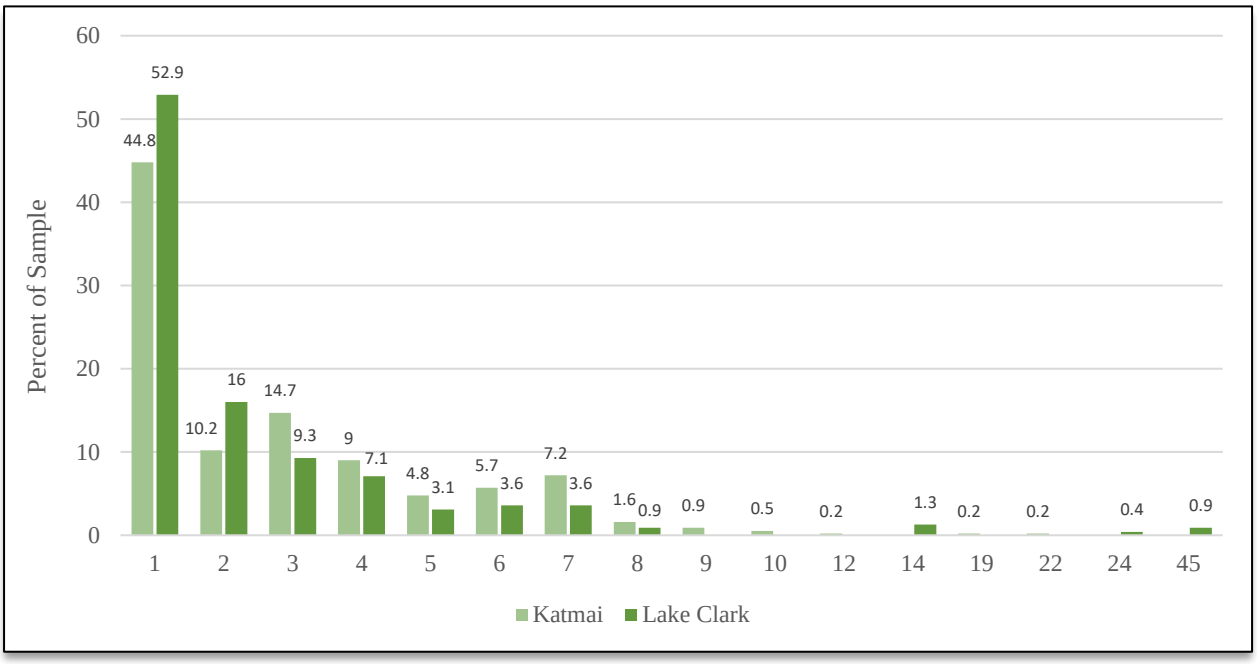


Figure 33. The number of days spent at KATM or LACL during the current visit.

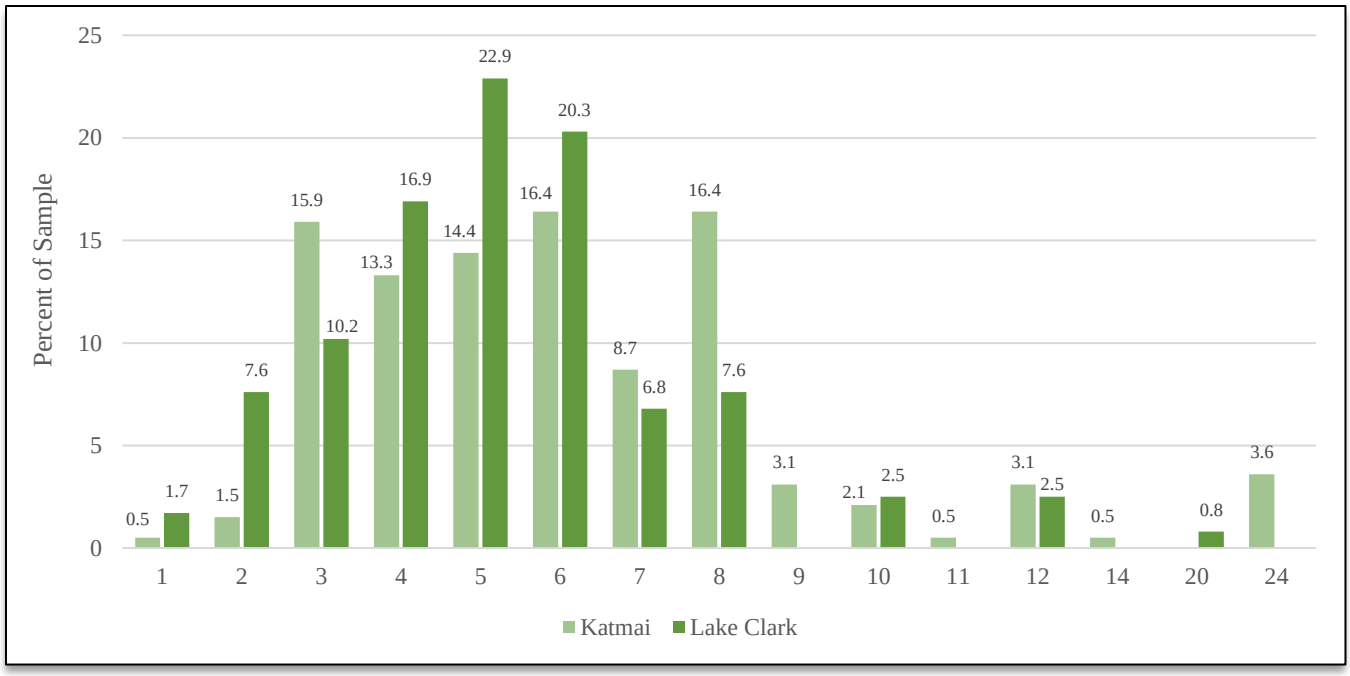


Figure 34. The number of hours spent at KATM or LACL, if the current visit was only for one day.

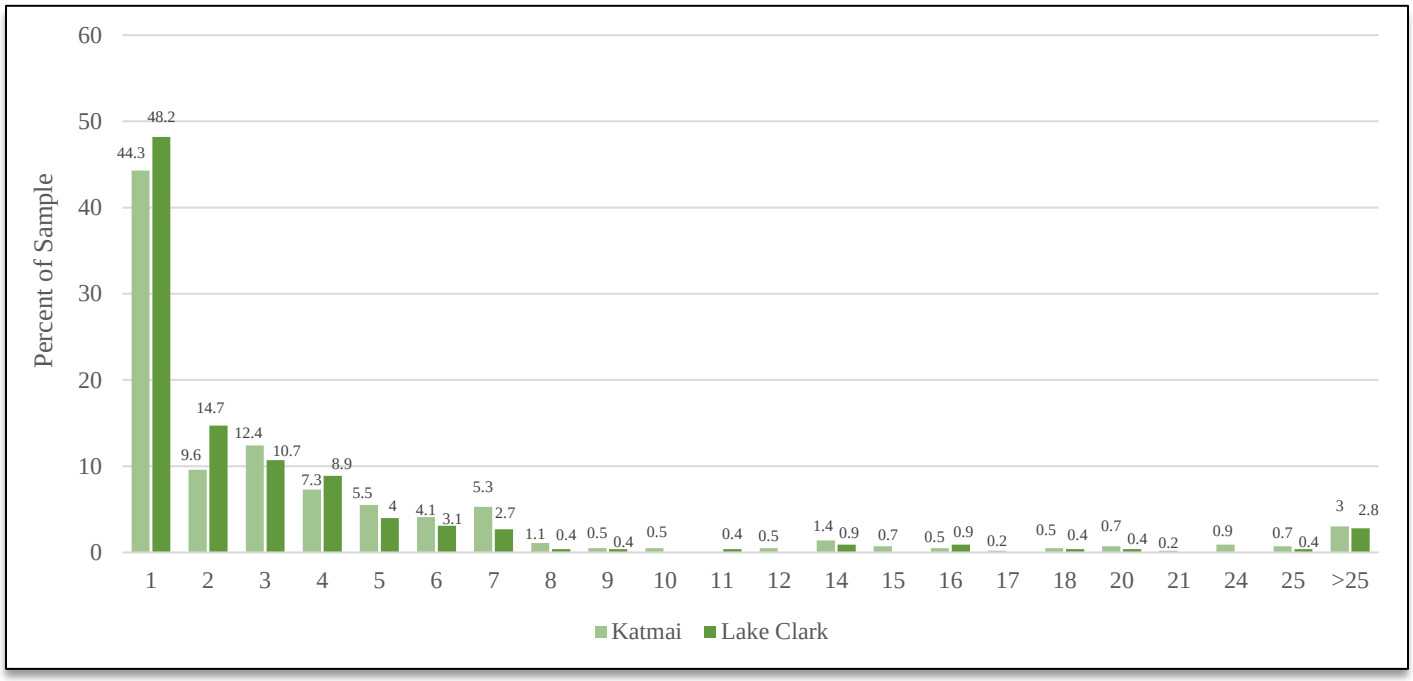


Figure 35. Including the current visit, the number of days in the last 5 years (60 months) the respondent has visited KATM or LACL.

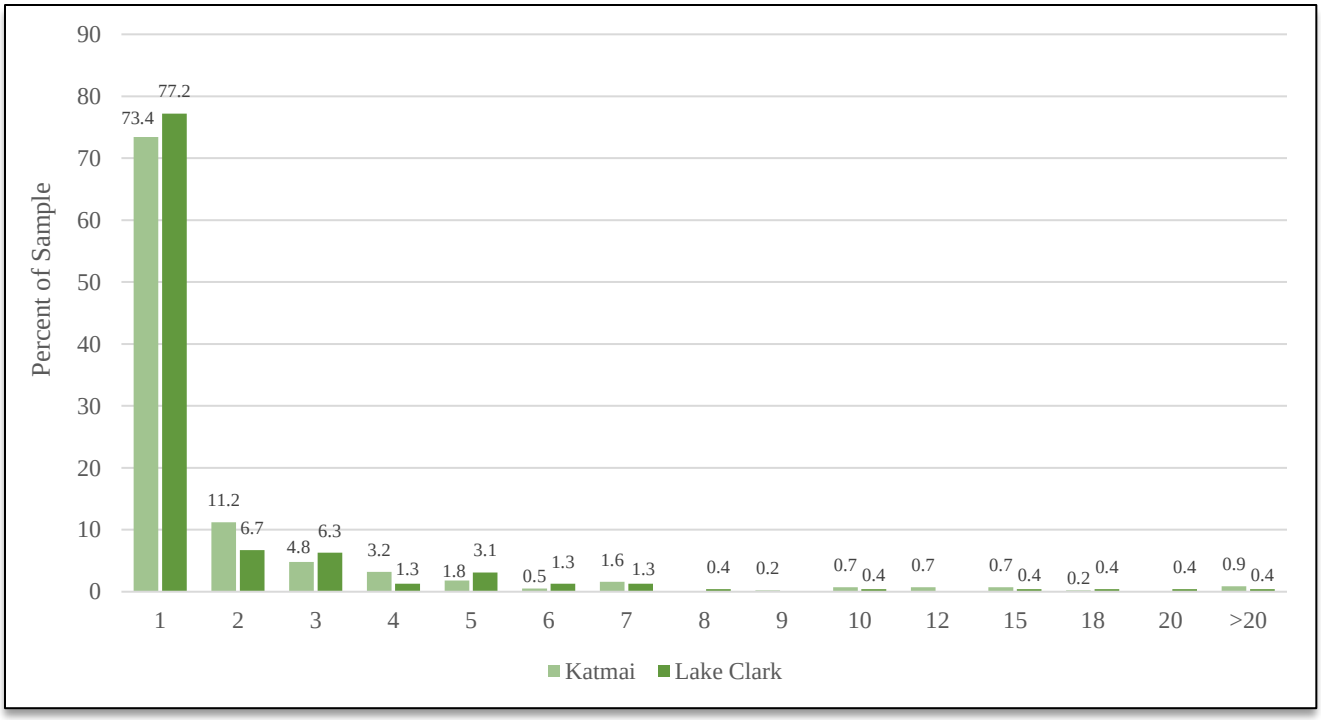


Figure 36. Including the current visit, the number of years (total) the respondent has visited KATM or LACL.

Table 7. *Past use history (PUH) of visitors to KATM and LACL.*

	Park	Mean (SD)	Min, Max	*t*-test
How many **days** did you spend visiting	KATM	2.91 (2.5)	1, 22	$t(665) = 0.03$
	LACL	2.90 (4.9)	1, 45	$p = 0.973$
If you visited for only one day, how many **hours**	KATM	6.51 (4.1)	1, 24	$t(310.9) = 3.15$
	LACL	5.33 (2.5)	1, 20	$p = 0.002$*
How many **days** in the last **five years**	KATM	5.04 (10.2)	1, 120	$t(658) = -0.08$
	LACL	5.13 (17.2)	1, 190	$p = 0.934$
How many **years** have you visited	KATM	1.97 (2.8)	1, 21	$t(658) = 0.37$
	LACL	1.89 (2.7)	1, 21	$p = 0.711$

Note. 'How many days in the last five years' and 'How many years have you visited' both include the current visit. *$p < 0.05$.

When split by intercept location, visitors intercepted at Crescent Lake reported an average trip length of 1.13 days, significantly lower ($p < 0.05$) than those intercepted at Chinitna Bay, Crosswinds Lake, the King Salmon Airport, Port Alsworth, or Silver Salmon Creek. Of visitors who spent only one day in the park, those intercepted at the King Salmon Airport reported spending significantly more hours ($p < 0.05$) at the park than did visitors intercepted anywhere else. Those intercepted at Hallo Bay reported spending significantly fewer hours ($p < 0.05$) at the park than did visitors intercepted at Crescent Lake or Crosswinds Lake. While differences were not statistically significant ($p > 0.05$) between Hallo Bay and Chinitna Bay, Port Alsworth, Silver Salmon Creek, or Upper Twin Lakes, relatively small sample sizes due to visits typically being longer than one day at each of the latter four, as well as large standard deviations for Upper Twin Lakes, Port Alsworth, and Chinitna Bay, hinder the ability to detect differences. Further, the number of days spent at the park in the last 5 years did not differ significantly ($p > 0.05$) across intercept locations. For the total number of years visited, only Crosswinds Lake and Hallo Bay were significantly different ($p < 0.05$), with visitors to Hallo Bay having visited approximately one year fewer, on average, than visitors to Crosswinds Lake.

Table 8. *Past use history of visitors intercepted at each location.*

		Chinitna Bay	Crescent Lake	Crosswinds Lake	Hallo Bay	King Salmon Airport	Port Alsworth	Silver Salmon Creek	Upper Twin Lakes
How many **days** did you spend visiting	Mean (SD)	3.42 (8.4)[1]	1.13 (0.6)[2]	3.05 (23)[1]	2.05 (2.0)	3.35 (3.0)[1]	3.81 (3.9)[1]	4.30 (3.2)[1]	2.22 (1.9)
	Min, Max	1, 45	1, 5	1, 9	1, 12	1, 22	1, 24	1, 14	1, 5
If you visited for only one day, how many **hours**	Mean (SD)	4.16 (3.5)[2,3]	6.16 (1.8)[2]	6.42 (1.6)[2]	4.29 (1.9)[3]	8.82 (5.8)[1]	5.29 (2.8)[2,3]	5.20 (0.8)	4.33 (3.0)[2,3]
	Min, Max	2, 20	4, 12	1, 10	2, 12	1, 24	1, 12	4, 6	2, 10
How many **days** in the last **five years**	Mean (SD)	5.73 (26.2)	3.00 (7.1)	6.46 (13.2)	3.19 (5.6)	4.92 (9.8)	5.94 (20.2)	8.00 (12.2)	4.00 (4.8)
	Min, Max	1, 190	1, 45	1, 120	1, 30	1, 86	1, 150	1, 60	1, 16
How many **years** have you visited	Mean (SD)	1.60 (2.8)	2.22 (3.1)	2.57 (3.7)[1]	1.40 (0.9)[2]	1.82 (2.7)	1.59 (1.4)	2.30 (3.6)	1.67 (1.66)
	Min, Max	1, 21	1, 18	1, 21	1, 5	1, 21	1, 7	1, 20	1, 6

Note. Superscripts in Mean row represent statistically significant differences ($p < 0.05$) in values between intercept locations.

Level of Crowding Experienced

At the beginning of the online survey (Appendix D), each respondent was asked to rate the average level of crowding experienced during their visit. These ratings were done using a seven-point Likert type scale, with 1 being not crowded and 7 being extremely crowded. On average, respondents reported feeling only slightly crowded, with an average rating of 1.85 from KATM and 1.37 from LACL. A majority of respondents (54.9% from KATM and 75.7% from LACL) reported not feeling crowded at all (1). Further, only 4.0% of respondents from KATM and 1.5% from LACL reported experiencing crowding levels above the neutral point (4). While respondents from KATM reported statistically higher ($p < 0.05$) levels of crowding than those from LACL, the average from both parks were well below crowded.

The mean level across all intercept locations was 1.5 (SD = 1.2). However, visitation levels are not even across locations. Crowding levels were statistically higher ($p < 0.05$) at Crosswinds Lake (M = 2.39) than at all other locations (M = 1.38), but still only 7.8% reported crowding levels higher than the neutral point. It is important to note, however, that the reported level of crowding by intercept location reflects the conditions experienced over the entire trip among visitors intercepted at that location and does not necessarily reflect the crowding level at each specific location.

Table 9. *Level of crowding experienced during the current park visit.*

Park	Not Crowded (1)	(2)	(3)	(4)	(5)	(6)	Extremely Crowded (7)	Mean (SD)	*t*-test
KATM	54.9	21.4	12.7	7.0	3.3	0.5	0.2	1.85 (1.2)	$t(592.9) = 6.1$
LACL	75.7	16.2	6.3	0.5	0.5	0.5	0.5	1.37 (0.8)	$p < 0.001$*

Note. Listed as percent of the sample. * $p < 0.05$.

Table 10. *Level of crowding experienced by intercept location.*

	Not Crowded (1)	(2)	(3)	(4)	(5)	(6)	Extremely Crowded (7)	Mean (SD)
Chinitna Bay	65.4	19.2	11.5	0	1.9	0	1.9	1.62 (1.1)^{B}
Crescent Lake	68.7	22.4	6.0	1.5	0	1.5	0	1.46 (0.9)^{B}
Crosswinds Lake	34.8	20.6	24.8	12.1	6.4	1.4	0	2.39 (1.3)^{A}
Hallo Bay	64.9	26.8	5.2	1.0	2.1	0	0	1.48 (0.8)^{B}
King Salmon Airport	64.3	19.0	7.7	7.1	1.2	0	0.6	1.64 (1.1)^{B}
Port Alsworth	88.5	9.6	1.9	0	0	0	0	1.13 (0.4)^{B}
Silver Salmon Creek	86.7	6.7	6.7	0	0	0	0	1.20 (0.6)^{B}
Upper Twin Lakes	88.9	11.1	0	0	0	0	0	1.11 (1.7)^{B}

Note. Listed as percent of the sample. Superscripts in the Mean column represent statistically significant ($p < 0.05$) differences in levels of crowding between intercept locations.

OVERALL NORMATIVE THRESHOLDS

Methods • **Normative Thresholds** • **Impact on Experience Quality**

Overall Normative Thresholds

Informed by management, park documents, conversations with visitors, and previous survey results, six indicators, or measurable and manageable aspects important to the visitor experience, were implemented into the thresholds survey distributed throughout the summer of 2019. These indicators include:

1. A visitor's distance to a focal bear
2. The amount of anthropogenic, or human-produced, sound heard per hour (e.g. generators, planes, other groups, etc.)
3. The number of other groups encountered per day
4. The number of fish caught with previous scarring (KATM only)
5. The amount of vegetation degradation near streams due to visitor use (LACL only)
6. The number of groups within view at one time
7. The number of bears viewed per hour.

The research team evaluated visitors' desired conditions for these indicators at KATM and LACL to understand the conditions that visitors deem to be: a) the minimally 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 revealed through survey responses to either a set of digitally manipulated images or brief descriptions of a range in condition from pristine to heavy use. For each condition, respondents were asked to rate its acceptability on a 9-point Likert scale (-4: Very unacceptable, -3: Unacceptable, -2: Moderately unacceptable, -1: Slightly unacceptable, 0: Neither unacceptable nor acceptable, 1: Slightly acceptable, 2: Moderately acceptable, 3: Acceptable, 4: Very acceptable). Unlike the 1-7 scale used for the level of crowding experienced, this scale used positive and negative values. This was done to better represent the polarity of responses. A negative value suggests unacceptable conditions while a positive value suggests acceptable conditions.

Because not all indicators applied to all visitors, different visitor types were presented with different indicators. All respondents were asked to respond to the acceptability of distance to a focal bear and the amount of anthropogenic sound per hour. Respondents who identified their primary activity as angling in a previous question were presented with two additional indicators: number of groups encountered per day and either number of scarred fish caught per day (KATM) or the amount of vegetation degradation seen near streams (LACL). All other respondents were presented with two different indicators: number of groups within view at one time and number of bears viewed per hour. Splitting the population in such a way limits the burden on any one respondent. The survey responses help to understand whether actual conditions aligned with or exceeded visitors' desired conditions for the various indicators at KATM and LACL.

In creating a norm curve for each indicator, the average acceptability is plotted for each condition. A sigmoidal trend line (i.e., *s*-shaped) most accurately reflects the curvature seen in acceptability ratings. However, to depict this efficiently, a fifth-order polynomial trend line is

added in Microsoft Excel to display the variation expected between tested conditions. If a trend does present as a lesser order polynomial or linear, the fifth-order polynomial displays it as such.

Bubble size is then added to the norm curves as a third variable. The width of the bubbles reflects the potential for conflict index (i.e. PCI_2) values, with larger bubbles depicting more disagreement, or potential for conflict. These are a measure of the average distance between respondents' acceptability ratings for a certain condition and range from 0 to 1, with 0 representing total agreement and 1 representing high disagreement across the sample. For example, if 50% of the sample rated a condition as very unacceptable and 50% rated the same condition as very acceptable, the PCI_2 value would approach one. In general, PCI_2 values less than 0.5 are considered acceptable and those greater than 0.5 warrant further investigation.

The bubbles are then colored in terms of acceptability, with green representing conditions deemed by visitors as acceptable, yellow representing conditions approaching or at a threshold, and red representing conditions that visitors report as unacceptable on average. The mean (i.e., average) acceptability rating is displayed next to each bubble. Next, small vertical lines are added to the norm curve at the average value for each of the tested evaluative dimensions (i.e. experienced condition, expected condition, management action, and displacement). For four indicators in this study (distance to a bear, vegetation degradation (LACL only), groups within view, and bears viewed per hour), respondents were able to select "None of these conditions" as the condition at which management action or displacement would occur. As a result, the averages for these values do not make interpretable sense and were analyzed separately. Finally, the point at which acceptability reaches zero (i.e. the threshold) is identified and labeled. This value is determined by solving for the x-intercept of the function for the trend line.

Responses for acceptability and evaluative dimensions were compared across the KATM and LACL samples using independent samples t-tests, which test the probability (*p*-value) that a new sample would produce a difference as or more extreme than the one seen, given there is no statistical difference between groups (i.e. parks). Ultimately, a *p*-value that is less than 0.05 indicates that KATM and LACL visitors differ statistically on the survey response for the specific question. The samples meet the assumptions of a t-test in that responses for individuals in one group do not influence responses for individuals in the other group (i.e. independence), sample sizes are relatively large so the data are assumed to be normally distributed, and the different groups have similar standard deviations (i.e. homogeneity). In cases where average acceptability did not differ statistically ($p > 0.05$) across parks at any condition, the values were averaged, and one curve is displayed for both parks. Otherwise, a separate curve was created for each park.

The same procedure was followed for evaluative dimensions. In cases where evaluative dimensions did not differ statistically ($p > 0.05$) across parks, the values were averaged, and one line was added to the norm curve. Otherwise, a separate line was added for each park.

Individual Distance to a Focal Bear

The acceptability of a visitor's distance to a focal bear was tested using visual methods, as described previously. All respondents, regardless of primary activity, were presented with this indicator. Researchers used five computer-manipulated photos, displaying a single focal bear at 10, 25, 50, 75, and 100 yards. All respondents were presented with all five photos because photo order has demonstrated limited or no influence on responses in field settings (e.g., Cribbs, Sharp, & Brownlee, 2019). Differences in acceptability across parks were not statistically different ($p > 0.05$), so one norm curve was created, displaying the average acceptability ratings across both parks. All evaluative dimensions were statistically different across parks, so park-specific evaluative dimensions were added to the curve. The condition with the lowest acceptability rating (M = 0.51) was 10 yards, 25 yards received the highest acceptability rating (M = 2.53), and acceptability decreased with increasing distance, beginning to plateau near 100 yards. As illustrated by the superscripts in the x-axis labels, acceptability at 10 yards was significantly lower than any other condition. Acceptability at 100 yards was the next lowest, followed by 75 yards, then 25 and 50 yards.

Since reported acceptability did not cross the x-axis, the line was statistically extended, or extrapolated, to identify thresholds. The threshold then is not a tested condition as it has been extrapolated beyond the five photos (represented by the dashed lines or extensions of the trend in the norm curve). For distance to a focal bear, the trend line crosses the x-axis at two points, once at 8.7 yards (i.e., too close) and then again at 219.6 yards (i.e., too far away). These thresholds can be interpreted as 8.7 yards being the closest acceptable condition and 219.6 yards being the farthest acceptable condition.

Prior to visiting KATM, respondents expected to see bears at an average of 25.3 yards. However, during their visit, if a bear was seen, the average distance experienced was 21.6 yards and the closest distance experienced was 12.7 yards. Prior to visiting LACL, respondents expected to see bears at an average of 29.5 yards. However, during their visit, if a bear was seen, the average distance experienced was 24.3 yards and the closest distance experienced was 18.6 yards.

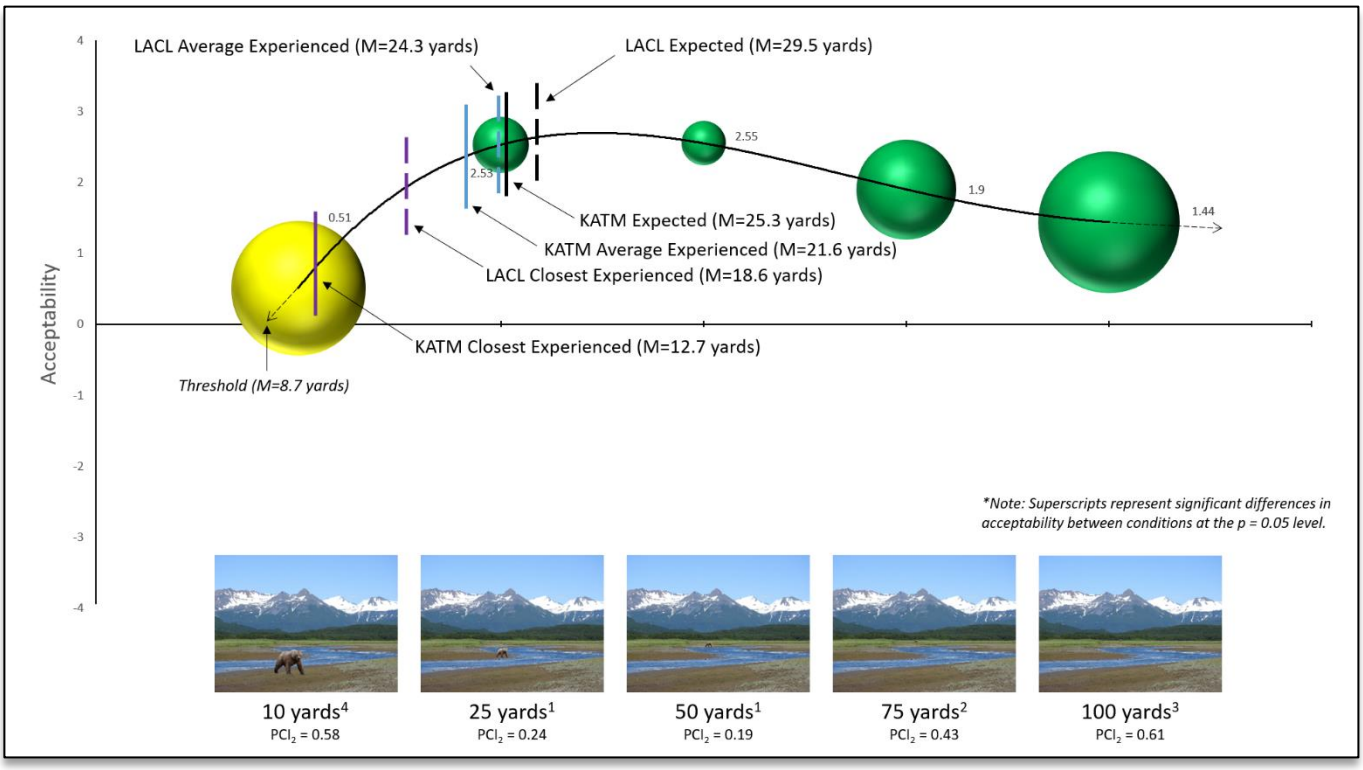


Figure 37. Social norm curve for distance to a focal bear displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions (KATM = solid vertical lines; LACL = dashed vertical lines).

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

As mentioned previously, PCI_2 values greater than 0.5 warrant additional analysis. In this specific norm curve, 2 conditions have PCI_2 values greater than 0.5: 10 yards (PCI_2=0.58) and 100 yards (PCI_2 = 0.61). To address these higher levels of disagreement, the researchers performed a K-means cluster analysis based on acceptability ratings at those specific conditions. K-means cluster analysis is a technique used to group responses based on selected variables in such a way as to maximize differences between groups (Likas, Vlassis, & Verbeek, 2003; Wagstaff, Cardie, Rogers, & Schrödl, 2001). The researcher selects the number of groups to create as well as the variables used to group responses, and the process is repeated with various numbers of groups until the optimal grouping is achieved. This subjectivity is what allows the researcher to ensure groupings are logically sound rather than only statistically significant. Through this process, three groups were identified at each of the two specified conditions (i.e., 10 and 100 yards): high, medium, and low acceptability. Each of these groups represents greater than 20% of the sample and have PCI_2 values less than 0.15, demonstrating the success of this technique. These new groupings are displayed using the same bubble technique as previously but have been made slightly transparent. The values next to each bubble represent the percent of the sample included (top) and the mean acceptability rating (bottom). These results show the large variation present in acceptability at either end of the scale. While the average acceptability levels may be slightly positive, many respondents view each condition as highly unacceptable and many view each as highly acceptable.

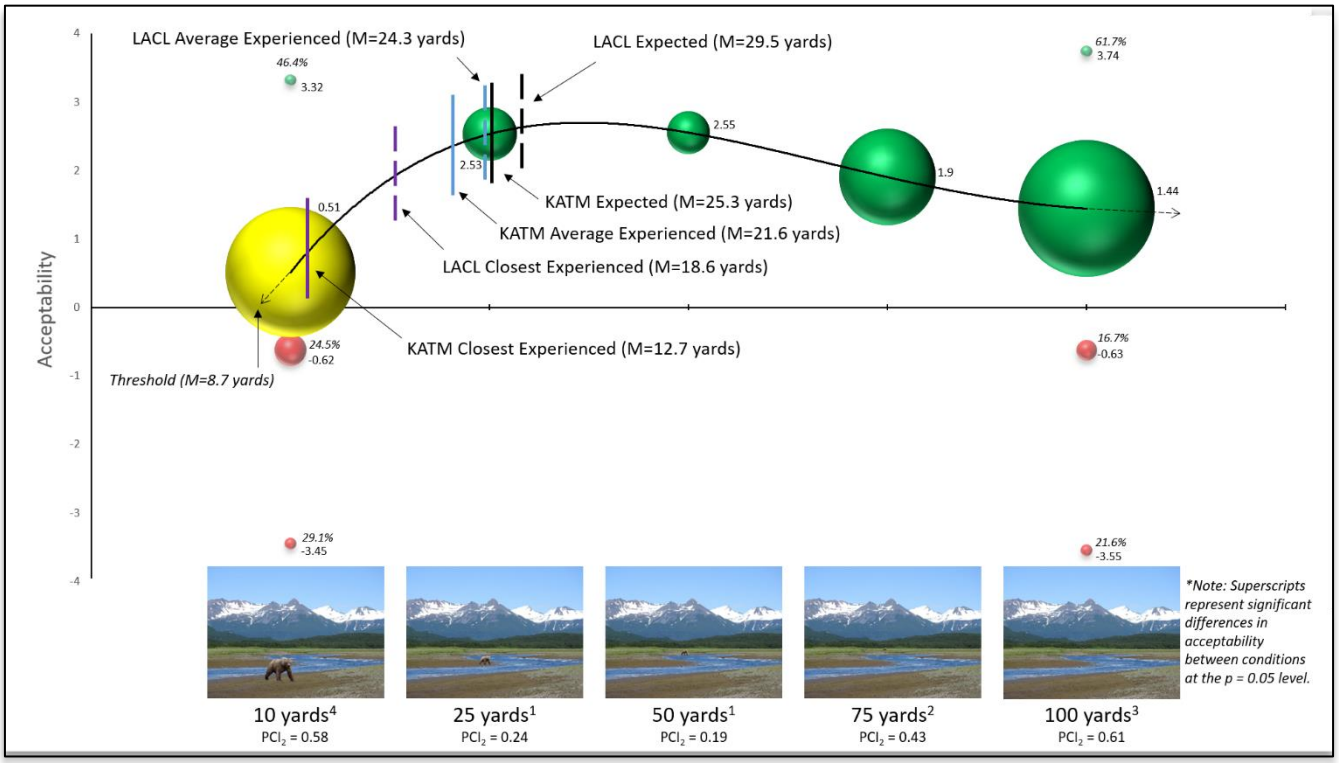


Figure 38. Social norm curve for distance to a focal bear displaying the mean acceptability, PCI_2 values, threshold, relevant evaluative dimensions (KATM = solid vertical lines; LACL = dashed vertical lines), and results of K-means clustering analysis.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable

To address the evaluative conditions of management action (the conditions deemed poor enough to warrant management action) and displacement (the conditions deemed poor enough to keep people from visiting), the researchers performed an additional K-means clustering analysis based on responses for both of these evaluative dimensions. This analysis included responses from both parks in order to maintain an adequate sample size in each of the groups. Four groups were selected: one with only displacement, one with only management action, one with both, and one with neither. These groups were plotted with the condition at which management action should occur on the x-axis and the condition at which displacement would occur on the y-axis. The size of each bubble represents the percent of the sample in that group. This value is also displayed numerically for each group. In the coming descriptions, groups are referred to as groups one, two, three, or four, based on the percent of the sample within each group, with group one being the largest and group four being the smallest.

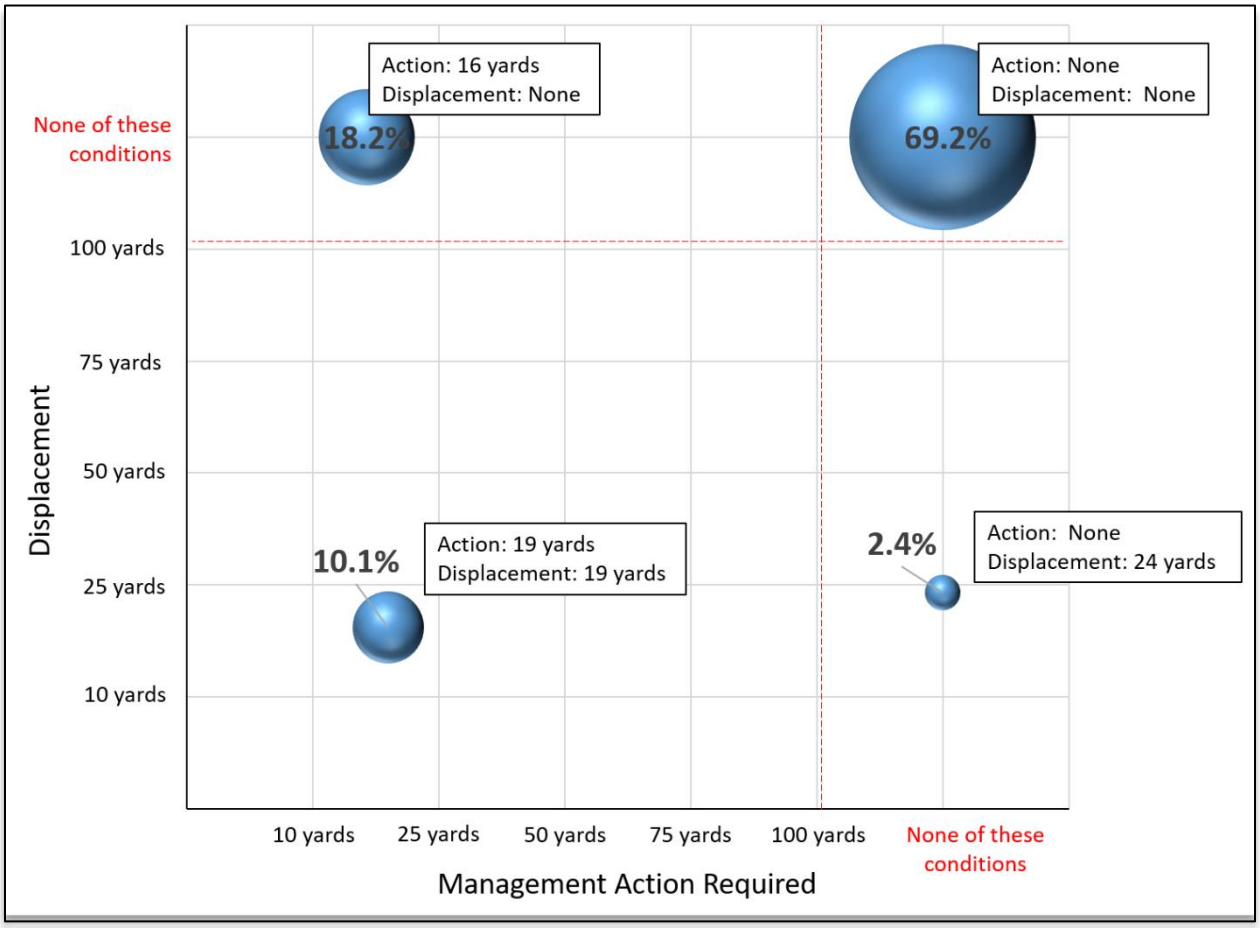


Figure 39. Evaluative dimensions of management action and displacement for visitors regarding their distance to a focal bear, analyzed using K-means clustering. Percentages represent the percent of the sample in each group. The dashed red lines represent the highest tested condition. Levels higher than this line represent a majority of the group selecting "none of these conditions" as poor enough to warrant either management action or displacement.

Group One. Group one represents 69.2% (430 responses) of all responses and consists of those individuals who reported none of the described conditions to be poor enough to warrant management action or displacement. This group is likely to be satisfied with their experience regardless of experienced conditions. Of this group, 25.7% were intercepted at Crosswinds Lake, 22.4% were intercepted at the King Salmon Airport, 11.3% were intercepted at Crescent Lake, 18.0% were intercepted at Hallo Bay, 5.3% were intercepted at Silver Salmon Creek (22 of 29 total Silver Salmon Creek responses), and 1.4% were intercepted at Twin Lakes (6 out of 9 total Twin Lakes responses). The average trip length was 2.95 (SD = 3.45) days or 5.84 (SD = 3.34) hours if less than one day. Respondents reported having visited the parks for 5.65 (SD = 3.34) days in the last five years and for 2.04 (SD = 2.94) years total. Seventy-four percent were with a guide, 49.3% were bear viewers, 30.2% were anglers, and 6.0% were backcountry campers and hikers. California (11.2%), International (9.4%), Alaska (9.1%), Colorado (6.3%), and Texas (5.3%) were the most common places of residence. Sixty-one percent identified as male, 42.8% received a graduate or professional degree, 34.0% received a four-year college degree, 26.1% reported an annual household income of $200,000 or greater, and 18.0% reported earning between $100,000 and $150,000. Approximately 81.2% identified as white, with all other identified races making up 4.6% (2.1% Asian). The average age was 54 (SD = 14.44) years old.

Group Two. Group two represents 18.2% (113 responses) of all responses and consists of those individuals who reported none of the described conditions to be poor enough to warrant displacement, but management action should occur at an average of 16 yards. It is likely that this group will be satisfied with their experience regardless of experienced conditions, but do not think visitors should approach within 16 yards of a bear. Of this group, 37.3% were intercepted at the King Salmon Airport, 14.5% were intercepted at Crosswinds Lake, 12.7% were intercepted at Chinitna Bay, and 11.8% were intercepted at Hallo Bay. The average trip length was 2.35 (SD = 1.98) days or 6.70 (SD = 4.57) hours if less than one day. Respondents reported having visited the parks for 2.96 (SD = 4.60) days in the last five years and for 1.39 (SD = 1.65) years total. Approximately 69.9% were with a guide, 54.9% were bear viewers, 17.7% were anglers, and 7.9% were backcountry campers and hikers. International (11.7%), Alaska (10.6%), Colorado (10.6%), California (9.7%), Texas (6.2%), and Washington (6.2%) were the most common places of residence. Almost 54% identified as male, 48.1% received a graduate or professional degree, 25.9% received a four-year college degree, 12% completed some college, 25.9% reported an annual household income of $200,000 or greater, and 19.4% reported earning between $100,000 and $150,000. Approximately 84.1% identified as white, with all other identified races making up 8.0% (5.3% Asian). The average age was 54 (SD = 15.79) years old.

Group Three. Group three represents 10.1% (63 responses) of all responses and consists of those individuals who reported management action and displacement should both occur at an average of 19 yards. It is likely that this group no longer feels safe when bears are within 19 yards and will avoid these conditions if possible. Of this group, 34.3% were intercepted at the King Salmon Airport, 16.4% were intercepted at Crosswinds Lake, 14.8% were intercepted at Crescent Lake, and 14.8% were intercepted at Port Alsworth. The average trip length was 3.49 (SD = 5.83) days or 6.60 (SD = 3.93) hours if less than one day. Respondents reported having visited the parks for 4.79 (SD = 6.56) days in the last five years and for 2.32 (SD = 3.49) years total. Approximately

76.2% were with a guide, 42.9% were bear viewers, 28.6% were anglers, and 11.1% were backcountry campers and hikers. California (12.7%), International (8.0%), Alaska (7.9%), and Missouri (6.3%) were the most common places of residence. About 70.2% identified as male, 49.1% received a graduate or professional degree, 28.1% received a four-year college degree, 28.1% reported an annual household income of $200,000 or greater, and 21.1% reported earning between $100,000 and $150,000. Lastly, 79.4% identified as white, with all other identified races making up 8.0% (2.3% Black or African American and Hispanic or Latino/Latina). The average age was 56 (SD = 12.66) years old.

Group Four. Group four represents 2.4% (15 responses) of all responses and consists of those individuals who reported none of the described conditions to be poor enough to warrant management action, but displacement would occur at an average of 24 yards. This group likely feels that the experienced conditions are simply a part of wildlife viewing and thus cannot be addressed with management action. However, the large proportion of photographers in this group suggest members may feel that viewing a bear any farther than 24 yards is no longer acceptable and another location may better satisfy their expectations. Of this group, 73.3% were intercepted in Lake Clark, with 21.4% intercepted at Crosswinds Lake, the King Salmon Airport, and Port Alsworth, and 14.3% intercepted at Chinitna Bay and Silver Salmon Creek. The average trip length was 4.40 (SD = 3.78) days or 3.80 (SD = 2.17) hours if less than one day. Respondents reported having visited the parks for 10.00 (SD = 10.91) days in the last five years and for 2.40 (SD = 1.92) years total. Approximately 73.3% were with a guide, 33.3% were photographers, 26.7% were bear viewers, and 20% were backcountry campers and hikers. Colorado (13.3%) and Texas (13.3%) were the most common places of residence, with 0 international responses. About 66.7% identified as male, 46.7% received a four-year college degree, 26.7% received a graduate or professional degree, 13.3% completed high school, 33.3% reported an annual household income of $200,000 or greater, and 20% reported earning between $50,000 and $75,000. Lastly, 93.3% identified as white, with no other races identified. The average age was 53 (SD = 18.43) years old.

Table 11. *Percent of respondents from each park reporting each level of acceptability for distance to a focal bear.*

	Park	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*- test
Photo 1	KATM	9.9	12.3	9.2	8.7	3.6	8.4	8.9	16.4	22.7	0.63 (2.9)[4]	$t(627) = 1.4$
10 yards	LACL	13.1	15.9	7.0	10.7	2.3	7.5	7.0	13.1	23.4	0.29 (3.0)[D]	$p = 0.179$
Photo 2	KATM	0.7	4.3	2.7	3.9	1.0	5.8	7.7	34.5	39.5	2.58 (2.0)[1]	$t(627) = 0.8$
25 yards	LACL	0.5	2.8	5.6	3.3	2.3	7.0	9.8	31.3	37.4	2.45 (2.0)[A]	$p = 0.457$
Photo 3	KATM	1.7	1.9	2.9	3.6	4.1	6.3	8.7	23.6	47.2	2.61 (2.0)[1]	$t(627) = 1.2$
50 yards	LACL	1.9	1.4	3.3	1.9	6.1	8.9	10.3	32.2	34.1	2.43 (1.9)[A]	$p = 0.247$
Photo 4	KATM	5.1	5.8	7.0	6.0	3.9	4.1	3.1	15.4	49.6	1.98 (2.7)[2]	$t(627) = 1.0$
75 yards	LACL	4.2	7.0	4.7	6.1	8.9	7.5	4.2	17.8	39.7	1.75 (2.6)[B]	$p = 0.309$
Photo 5	KATM	12.0	9.9	4.8	2.2	4.1	3.1	1.9	10.8	51.1	1.54 (3.2)[3]	$t(627) = 1.2$
100 yards	LACL	11.7	9.3	6.1	5.6	6.1	3.7	2.8	12.1	42.5	1.23 (3.1)[C]	$p = 0.242$

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings within each park.

Table 12. *Percent of respondents from each park reporting each condition for evaluative dimensions of distance to a focal bear.*

	Park	Photo 1 10 yards (1)	Photo 2 25 yards (2)	Photo 3 50 yards (3)	Photo 4 75 yards (4)	Photo 5 100 yards (5)	I did not see any bears	None of these conditions	Mean (SD)	*t*-test
Expected	KATM	28.3	51.3	14.0	3.1	3.1			2.01 (0.9)	$t(391.7) = -2.1$
	LACL	22.9	51.4	16.4	3.3	6.1			2.18 (1.0)	$p = 0.044$*
Average Experienced	KATM	32.7	44.6	7.0	1.0	1.2	13.6		1.77 (0.8)	$t(531) = -2.4$
	LACL	26.6	41.6	8.9	1.4	3.7	17.8		1.95 1.0)	$p = 0.015$*
Closest Experienced	KATM	74.8	9.4	0.7	0	1.2	13.8		1.18 (0.6)	$t(245.2) = -5.1$
	LACL	50.0	25.2	2.3	1.9	2.8	17.8		1.57 (0.9)	$p = 0.001$*
Management Action	KATM	16.7	5.4	5.4	4.2	5.6		62.7	2.38 (1.5)	$t(231) = 1.63$
	LACL	22.0	6.1	1.9	2.3	5.6		62.1	2.04 (1.5)	$p = 0.104$
Displacement	KATM	5.9	0.2	4.2	3.9	9.8		76.0	3.48 (1.6)	$t(161) = 2.0$
	LACL	12.2	0.9	3.8	3.3	10.3		69.5	2.95 (1.8)	$p = 0.051$

Note. Highest percentages across rows are highlighted. *$p < 0.05$. Means, standard deviations, and *t*-tests do not include opt out categories of "I did not see any bears" or "None of these conditions."

Anthropogenic Sound Heard per Hour

The acceptability of anthropogenic sound was measured at five conditions: 0, 15, 30, 45, and 60 minutes per hour. Similar to the distance to a focal bear, this indicator was presented to all respondents, regardless of activity type, and all respondents rated the acceptability of all five conditions. Respondents were presented with a sliding scale to select a specific number of minutes per hour for each evaluative dimension rather than limiting choices to the five listed conditions. This was done to detect fine-scale differences that course condition classes would miss since variation is likely to be limited to lower levels. For example, if respondents hear anthropogenic sound for less than 15 minutes per hour, all responses look similar. By allowing respondents to select more precise answers, the researchers can detect finer differences within indicator conditions. Acceptability was statistically different ($p < 0.05$) between parks, so unique norm curves were created for KATM and LACL.

For KATM, 0 minutes per hour received the highest acceptability rating (M = 2.94) and acceptability decreased as conditions worsened. Differences in acceptability were statistically significant ($p < 0.05$) across all conditions. The highest level of disagreement (i.e. PCI_2; 0.46) occurred near the threshold at 15 minutes. Prior to their visit, KATM respondents expected to hear anthropogenic sound for an average of 12.1 minutes per hour but experienced an average of 13.0 minutes and a maximum of 17.2 minutes per hour. The condition at which acceptability hits zero, or the threshold, is 15.7 minutes per hour while management action should occur at 29.6 minutes and displacement would occur at 37.7 minutes per hour. Respondents are hearing anthropogenic sound more often than expected, and at times, greater than the threshold, but still well below levels warranting management action or displacement.

For LACL, 0 minutes per hour received the highest acceptability rating (M = 2.73) and acceptability decreased as conditions worsened. Differences in acceptability were statistically significant ($p < 0.05$) across all conditions. The highest level of disagreement (i.e. PCI_2; 0.37) occurred near the threshold (22.5 minutes) at 15 minutes heard per hour. Prior to their visit, LACL respondents expected to hear anthropogenic sound for an average of 12.7 minutes per hour but experienced an average of 14.5 minutes and a maximum of 17.7 minutes per hour. The condition at which acceptability hits zero, or the threshold, is 22.5 minutes per hour while management action should occur at 31.0 minutes and displacement would occur at 39.2 minutes per hour. Respondents are hearing anthropogenic sound more often than expected and at times, greater than the threshold, but still well below levels warranting management action or displacement.

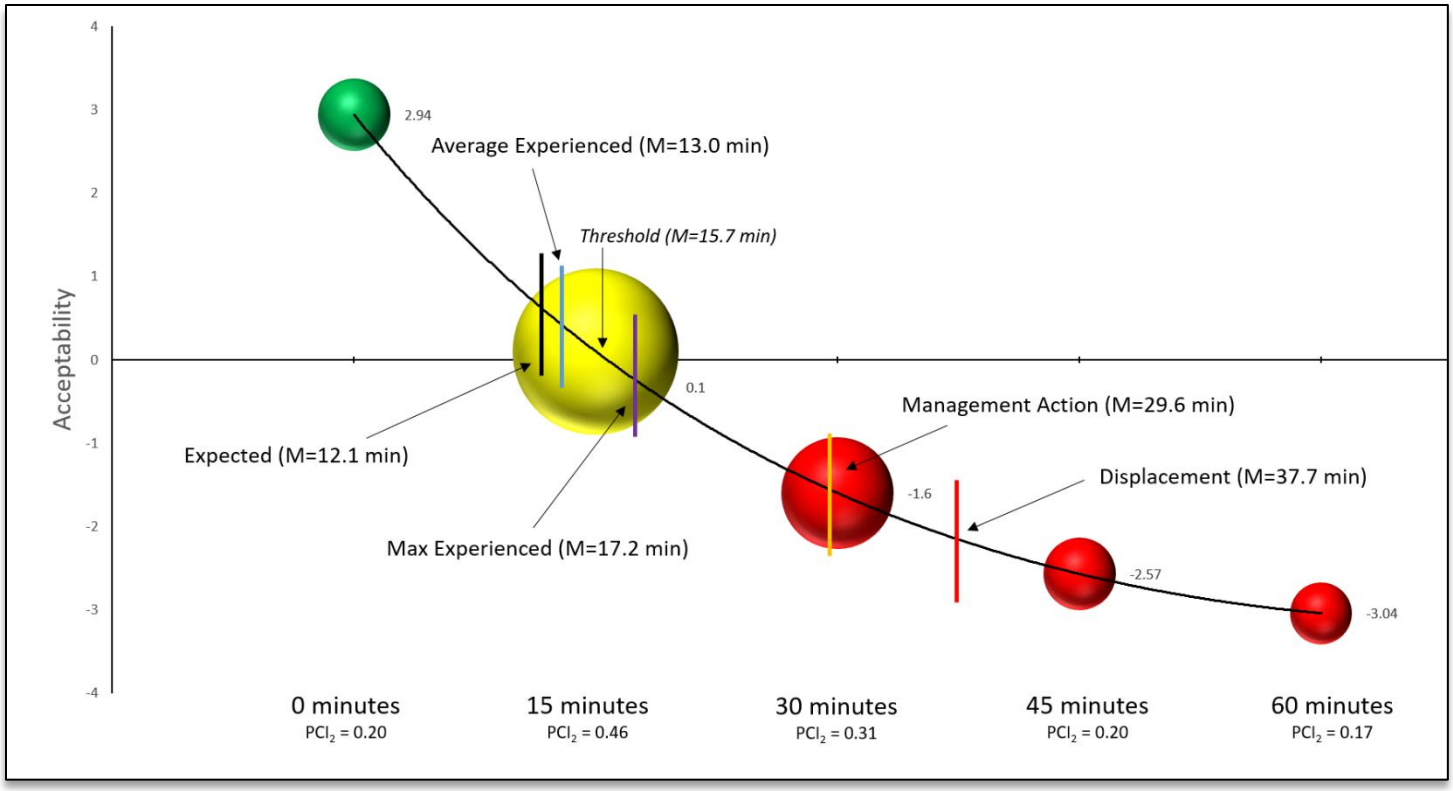


Figure 40. KATM social norm curve for anthropogenic sound heard per hour displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions. Acceptability was statistically different ($p < 0.05$) across all conditions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

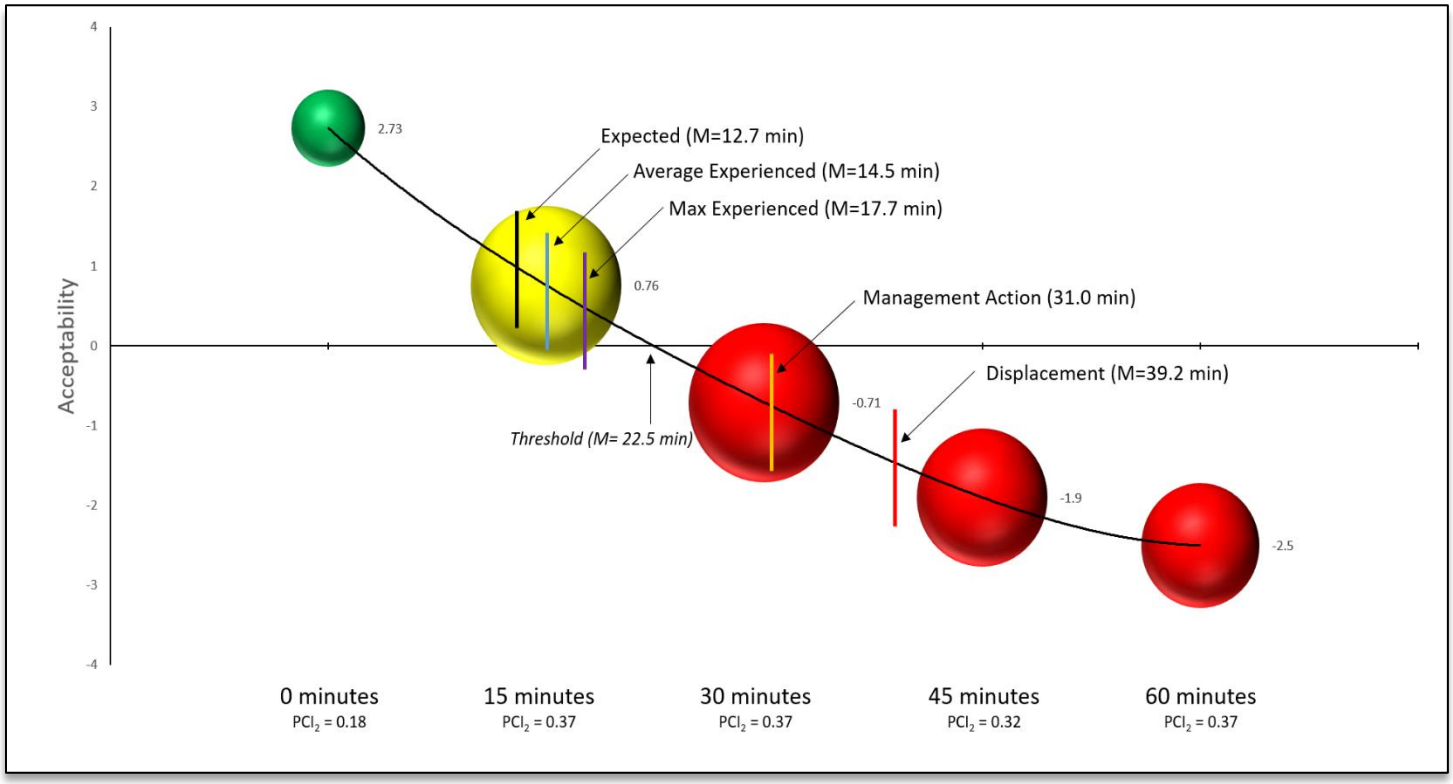


Figure 41. *LACL* social norm curve for anthropogenic sound heard per hour displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions. Acceptability was statistically different ($p < 0.05$) across all conditions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 13. *Percent of respondents reporting each level of acceptability for increasing minutes of anthropogenic sound per hour.*

	Park	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*-test
No human sounds	KATM	2.8	2.6	1.0	1.3	7.7	1.5	2.0	13.5	67.6	2.94 (2.1)[1]	$t(598) = 1.2$
	LACL	1.9	0.5	3.8	2.9	12.5	0.5	1.9	15.4	60.6	2.73 (2.1)[A]	$p = 0.227$
15 minutes	KATM	8.7	13.3	9.7	13.0	7.9	8.7	14.3	18.1	6.4	0.10 (2.5)[2]	$t(448.8) = -3.2$
	LACL	4.8	8.2	7.2	10.6	12.5	11.5	10.1	27.4	7.7	0.76 (2.4)[B]	$p = 0.002$*
30 minutes	KATM	23.5	22.7	12.8	13.3	8.4	6.9	5.4	5.4	1.8	-1.60 (2.2)[3]	$t(598) = -4.5$
	LACL	13.9	15.9	13.5	13.0	13.9	8.2	6.3	10.1	5.3	-0.71 (2.4)[C]	$p < 0.001$*
45 minutes	KATM	42.6	25.3	12.5	6.1	4.6	2.6	2.6	2.3	1.5	-2.57 (1.9)[4]	$t(353.3) = -3.5$
	LACL	33.2	24.0	9.1	8.7	8.7	3.8	4.3	3.8	4.3	-1.90 (2.4)[D]	$p = 0.001$*
60 minutes	KATM	65.6	15.3	5.1	3.3	4.6	0.8	1.0	2.3	2.0	-3.04 (1.9)[5]	$t(345.6) = -2.8$
	LACL	54.3	20.2	2.4	2.9	8.7	1.9	1.0	3.4	5.3	-2.50 (2.4)[E]	$p = 0.005$*

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings within parks. *$p < 0.05$.

Table 14. *Descriptive statistics for each evaluative dimension regarding the amount of anthropogenic sound heard per hour.*

	Park	Mean (SD) minutes	Min, Max minutes	*t*-test
Expected	KATM	12.05 (12.5)	0, 60	$t(472.4) = -0.6$
	LACL	12.68 (10.7)	0, 60	$p = 0.525$
Average Experienced	KATM	13.01 (12.6)	0, 60	$t(593) = -1.4$
	LACL	14.50 (13.2)	0, 60	$p = 0.175$
Maximum Experienced	KATM	17.15 (15.9)	0, 60	$t(586) = -0.4$
	LACL	17.7 (14.9)	0, 60	$p = 0.684$
Management Action	KATM	29.63 (18.0)	0, 60	$t(582) = -0.9$
	LACL	31.02 (17.5)	0, 60	$p = 0.372$
Displacement	KATM	37.65 (18.9)	0, 60	$t(582) = -1.0$
	LACL	39.24 (18.6)	0, 60	$p = 0.336$

Groups Encountered per Day

The acceptability for groups encountered per day was tested at six different conditions: 0, 3, 6, 9, 12, and 15 groups. Due to average travel party size and aircraft capacity, a group was defined as between three and six individuals (visitors were informed of 'group size' when completing the questionnaire). Unlike the previous two indicators, groups encountered per day was only presented to respondents who selected angling as the primary activity during their visit. Differences in acceptability were statistically different ($p < 0.05$) across parks, so unique norm curves were created for KATM and LACL.

For KATM, the highest level of acceptability occurred at 0 groups (M = 3.46) and acceptability decreased approximately linearly until 9 groups (M = -2.4) when the trend began to plateau. Acceptability differed statistically between all conditions ($p < 0.05$). The highest PCI_2 value (0.43) occurred near the threshold at 6 groups. Prior to visiting KATM, respondents expected to see an average of 3.5 other groups per day but experienced an average of 5.0 groups, still below the threshold of 6.2 groups per day. Management action and displacement are warranted at 9.6 and 11.8 groups respectively.

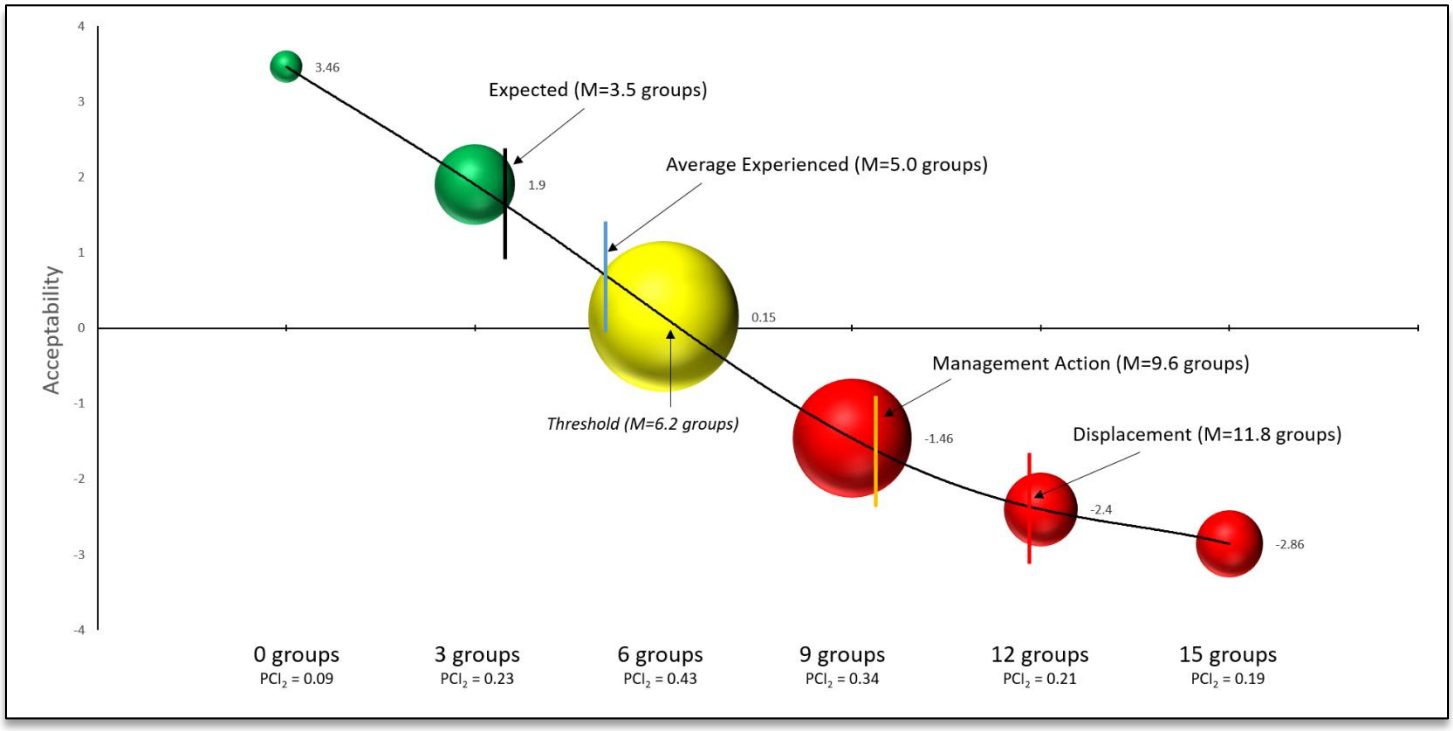


Figure 42. KATM social norm curve for groups encountered per day displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions. Acceptability was statistically different ($p < 0.05$) across all conditions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

For LACL, the highest level of acceptability occurred at 0 groups (M = 2.74) and acceptability decreased approximately linearly until 9 groups (M = -1.26) when the trend began to plateau. With the exception of the first two conditions, acceptability differed statistically between all other conditions ($p < 0.05$). The highest PCI_2 value (0.40) occurred slightly past the threshold (6.3 groups) at 9 groups although all conditions of 6 groups or greater resulted in PCI_2 values greater than 0.3. Prior to visiting LACL, respondents expected to see an average of 4.1 other groups per day and experienced an average of 3.9 groups, well below the threshold of 6.3 groups per day. Management action and displacement are warranted at 9.1 and 15.0 groups respectively.

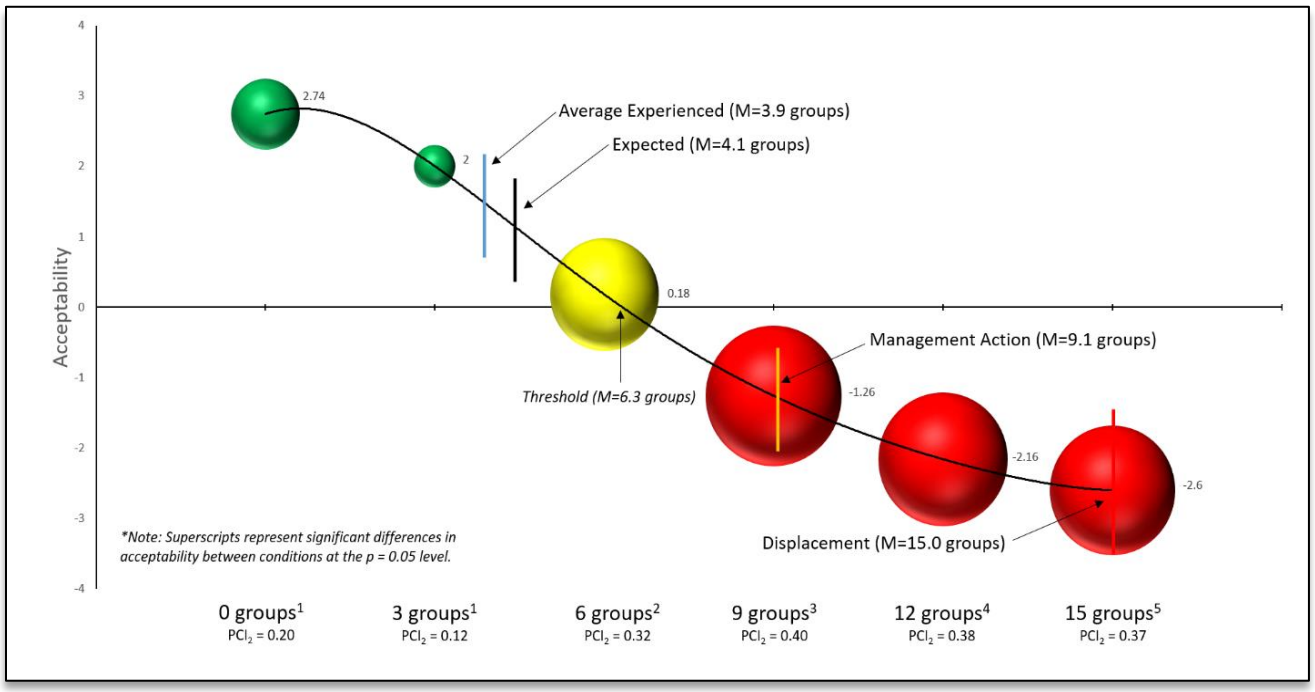


Figure 43. LACL social norm curve for groups encountered per day displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 15. *Percent of respondents reporting each level of acceptability for groups encountered per day.*

	Park	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*-test
0 groups	KATM	1.0	0	1.9	1.0	3.8	1.0	0	12.4	79.0	3.46 (1.4)[1]	$t(68.2) = 2.0$
	LACL	6.0	0	0	2.0	14.0	0	0	12.0	66.0	2.74 (2.3)[A]	$p = 0.046$*
3 groups	KATM	1.0	3.8	1.9	8.6	5.7	8.6	16.2	41.0	13.3	1.90 (1.9)[2]	$t(153) = -0.3$
	LACL	2.0	0	0	6.0	12.0	16.0	8.0	42.0	14.0	2.00 (1.7)[A]	$p = 0.742$
6 groups	KATM	8.6	6.7	16.2	12.4	6.7	12.4	15.2	16.2	5.7	0.15 (2.4)[3]	$t(153) = -0.1$
	LACL	4.0	4.0	14.0	24.0	12.0	12.0	10.0	14.0	6.0	0.18 (2.1)[B]	$p = 0.945$
9 groups	KATM	21.9	19.0	19.0	9.5	8.6	9.5	3.8	4.8	3.8	-1.46 (2.3)[4]	$t(153) = -0.5$
	LACL	22.0	14.0	22.0	14.0	4.0	8.0	2.0	6.0	8.0	-1.26 (2.5)[C]	$p = 0.629$
12 groups	KATM	43.8	21.0	9.5	7.6	8.6	2.9	1.0	2.9	2.9	-2.40 (2.1)[5]	$t(153) = -0.6$
	LACL	42.0	24.0	6.0	8.0	20	6.0	2.0	6.0	4.0	-2.16 (2.4)[D]	$p = 0.530$
15 groups	KATM	61.9	12.4	8.6	3.8	5.7	2.9	0	1.9	2.9	-2.86 (2.0)[6]	$t(153) = -0.7$
	LACL	58.0	16.0	8.0	4.0	0	2.0	4.0	2.0	6.0	-2.60 (2.4)[E]	$p = 0.482$

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) between acceptability ratings within each park. *$p < 0.05$.

Table 16. *Percent of respondents reporting each condition for evaluative dimensions of groups encountered per day.*

	Park	0 groups (1)	3 groups (2)	6 groups (3)	9 groups (4)	12 groups (5)	15 groups (6)	Mean (SD)	*t*-test
Expected	KATM	15.2	64.8	12.4	3.8	1.9	1.9	2.18 (0.9)	$t(153) = -1.2$
	LACL	12.0	60.0	16.0	4.0	6.0	2.0	2.38 (1.1)	$p = 0.269$
Average Experienced	KATM	5.7	50.5	25.7	11.4	4.8	1.9	2.65 (1.0)	$t(121.1) = 2.3$
	LACL	8.0	64.0	22.0	2.0	4.0	0	2.30 (0.8)	$p = 0.026$*
Management Action	KATM	2.9	5.8	23.1	27.9	17.3	23.1	4.20 (1.3)	$t(152) = 0.7$
	LACL	2.0	14.0	22.0	20.0	24.0	18.0	4.04 (1.4)	$p = 0.497$
Displacement	KATM	1.9	1.0	11.5	15.4	26.9	43.3	4.94 (1.2)	$t(152) = -0.3$
	LACL	2.0	2.0	8.0	22.0	14.0	52.0	5.00 (1.3)	$p = 0.785$

Note. Highest percentages across rows are highlighted. *$p < 0.05$.

Fish Caught per Day with Previous Scarring (KATM only)

The acceptability of fish caught per day with previous scarring was tested at 6 conditions: 0, 2, 4, 6, 8, and 10 fish. Like groups encountered per day, fish caught with previous scarring was only presented to respondents selecting angling as the primary activity during their trip. This indicator was not chosen for LACL, so all analysis is KATM-specific, including the social norm curve.

The condition with the highest reported acceptability was 0 fish caught with previous scarring (M = 3.51). The acceptability then decreased approximately linearly as the number of fish increased. With this increase, the level of disagreement around each point increased as well with a PCI_2 value of 0.07 for 0 fish and 0.42 for 10 fish. Acceptability differed statistically between all conditions ($p < 0.05$). Prior to visiting KATM, respondents expected to catch 2.0 fish per day with visible scarring from previous catch and release and experienced an average of just that. The threshold, where acceptability reaches zero, is 5.9 fish, well above the experienced condition. Management action and displacement were warranted at 7.4 and 8.6 fish per day, respectively.

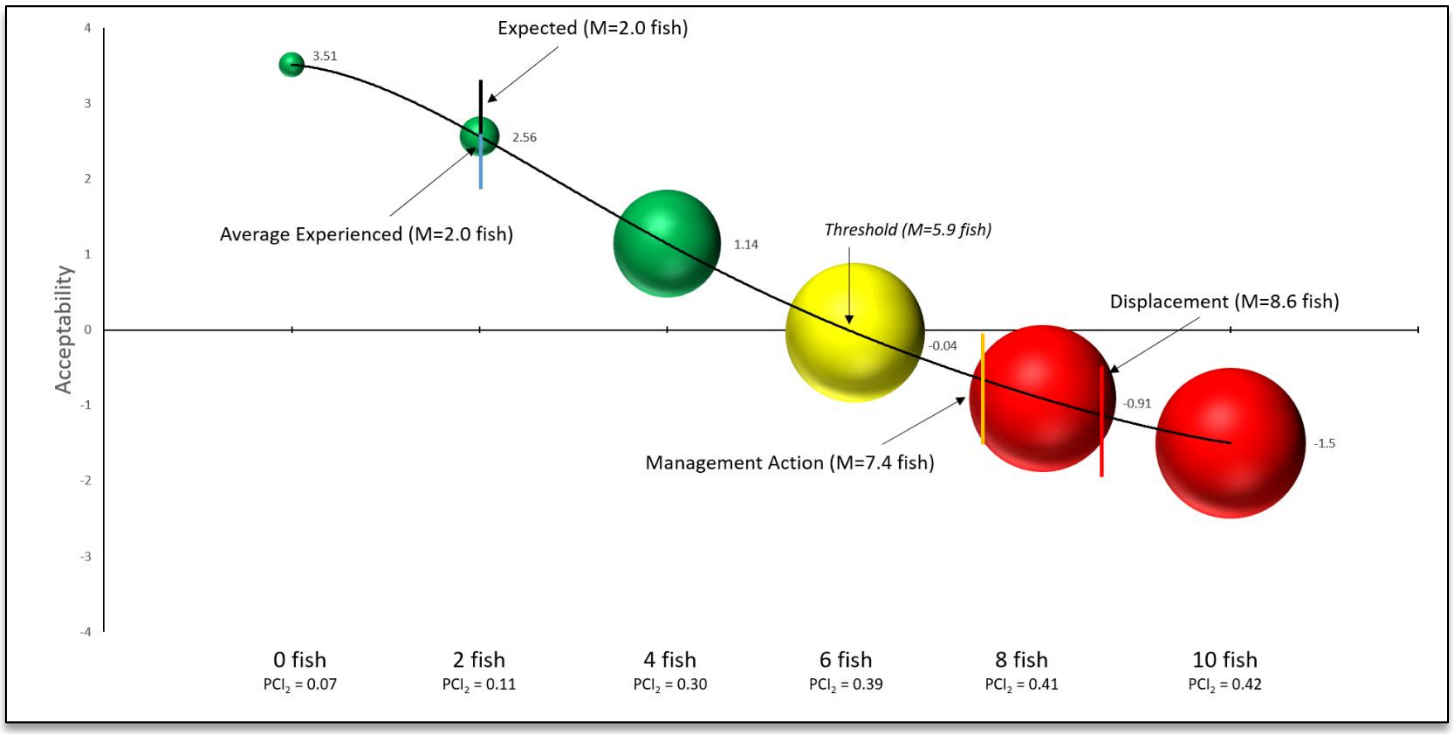


Figure 44. Social norm curve for fish caught per day with previous scarring displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions. Acceptability was statistically different ($p < 0.05$) across all conditions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 17. *Percent of respondents reporting each level of acceptability for fish caught per day with previous scarring.*

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)
0 fish	1.9	0	0	0	6.7	0	0	6.7	84.6	3.51 (1.5)[1]
2 fish	1.0	1.9	1.0	1.0	9.6	6.7	9.6	34.6	34.6	2.56 (1.7)[2]
4 fish	1.9	4.8	6.7	12.5	13.5	10.6	11.5	25.0	13.5	1.14 (2.2)[3]
6 fish	7.7	14.4	9.6	12.5	14.4	10.6	8.7	14.4	7.7	-0.04 (2.5)[4]
8 fish	18.3	19.2	10.6	12.5	10.6	6.7	6.7	8.7	6.7	-0.91 (2.6)[5]
10 fish	36.5	13.5	7.7	8.7	9.6	6.7	4.8	5.8	6.7	-1.5 (2.7)[6]

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings.

Table 18. *Percent of respondents reporting each condition for evaluative dimensions of fish caught per day with previous scarring.*

	0 fish (1)	2 fish (2)	4 fish (3)	6 fish (4)	8 fish (5)	10 fish (6)	Mean (SD)
Expected	38.5	42.3	7.7	6.7	0	4.8	2.02 (1.2)
Average Experienced	36.5	45.2	9.6	3.8	0	4.8	2.00 (1.2)
Management Action	4.9	1.9	15.5	16.5	16.5	44.7	4.72 (1.5)
Displacement	5.8	1.0	3.9	7.8	11.7	69.9	5.28 (1.4)

Note. Highest percentages across rows are highlighted.

Vegetation Degradation surrounding Angling Sites (LACL only)

The acceptability of vegetation degradation surrounding angling sites was tested at 5 conditions: 0, 10, 25, 45, and 70 percent degraded. Like groups encountered per day, amount of vegetation degradation was only presented to respondents selecting angling as the primary activity during their trip. This indicator was not chosen for KATM, so all analysis is LACL-specific, including the social norm curve.

The condition with the highest reported acceptability was 0 percent degraded (M = 3.68). The acceptability then decreased approximately linearly as the percent degraded increased. With this increase, the level of disagreement around each point increased as well with a PCI_2 value of 0.00 for 0% and 0.42% for 70%. Acceptability differed statistically between all conditions ($p < 0.05$). Prior to visiting LACL, respondents expected to see vegetation degradation at 10% of the site and experienced an average of slightly less (M = 9.2%). The threshold, where acceptability reaches zero, is 48.7%, well beyond the experienced condition.

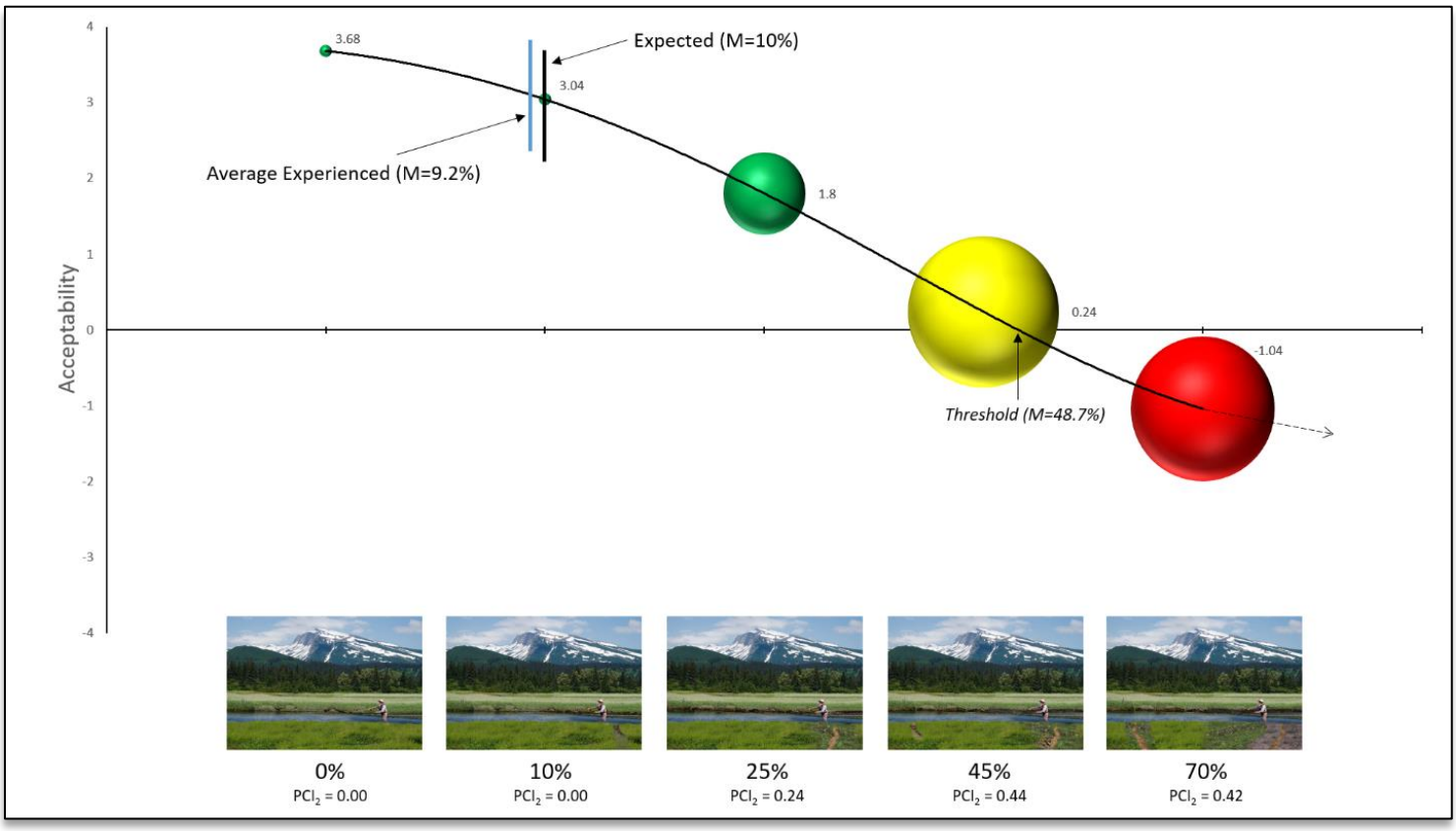


Figure 45. Social norm curve for amount of vegetation degradation surrounding angling sites displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions. Acceptability was statistically different ($p < 0.05$) across all conditions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

To address the evaluative conditions of management action (the conditions deemed poor enough to warrant management action) and displacement (the conditions deemed poor enough to keep people from visiting), the researchers performed an additional K-means clustering analysis, based on responses for both of these evaluative dimensions. This analysis included only responses from LACL since this particular indicator was not chosen for KATM. Three groups were selected: one with neither management action nor displacement and three with various levels of both. These groups were plotted with the condition at which management action should occur on the x-axis and the condition at which displacement would occur on the y-axis (Figure 27). The size of each bubble represents the percent of the sample in that group. This value is also displayed numerically for each group. In the coming descriptions, groups are referred to as groups one, two, or three, based on the percent of the sample within each group, with group one being the largest and group three being the smallest.

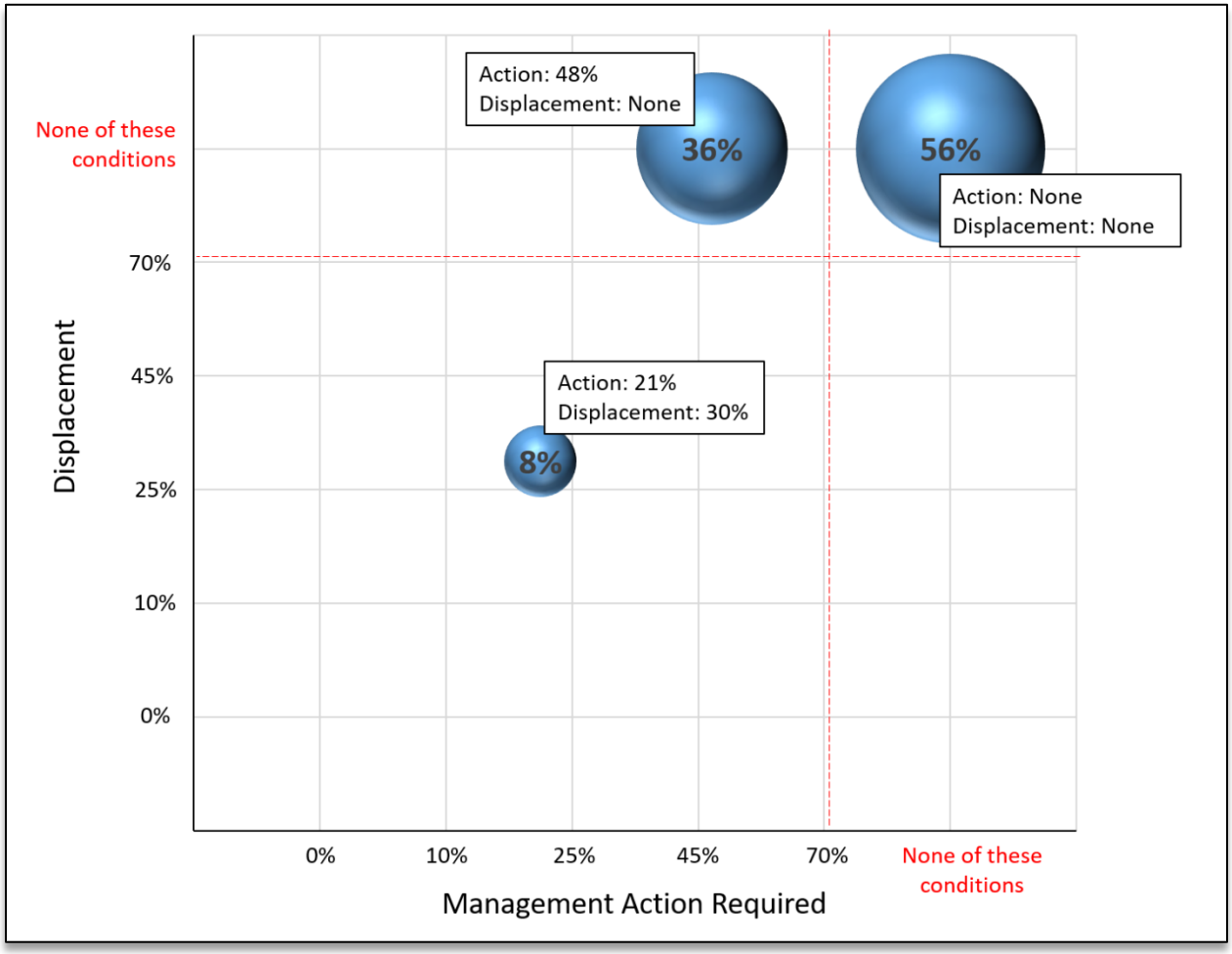


Figure 27. Evaluative dimensions of management action and displacement for groups within view at one time, analyzed using K-means clustering. Percentages represent the percent of the sample in each group. The dashed red lines represent the highest tested condition. Levels higher than this line represent a majority of the group selecting "none of these conditions" as poor enough to warrant either management action or displacement.

Group One. Group one represents 56% (28 responses) of all responses and consists of those individuals who reported none of the described conditions to be poor enough to warrant either management action or displacement. This group is likely to be satisfied with their experience regardless of the experienced conditions. Since this indicator was only provided to anglers at LACL, 100% of all groups were anglers intercepted in LACL. In group one, 92.9% were intercepted at Crescent Lake and 7.1% were intercepted at Silver Salmon Creek. The average trip length was 1.25 (SD = 0.59) days or 5.83 (SD = 1.47) hours if less than one day. Respondents reported having visited the parks for 5.14 (SD = 10.75) days in the last five years and for 2.50 (SD = 3.42) years total. Approximately 85.7% were guided. Alaska (21.4%) and Washington (14.3%) were the most common places of residence, with 0 international responses. About 75% identified as male, 28.6% received some college education, 21.4% received a four-year college degree, 21.4% received a two-year college degree, and 17.9% received a graduate or professional degree. In terms of income, 32.1% reported an annual household income between $100,000 and $149,999, 21.4% reported earning greater than $200,000, and 17.9% reported earning between $150,000 and $199,999. Lastly, 78.6% identified as white, 7.1% as Hispanic or Latino/Latina, and 3.6% as American Indian or Alaska Native. The average age was 56 (SD = 15.48) years old.

Group Two. Group two represents 36% (18 responses) of all responses and consists of those individuals who reported management action should occur at 48% degraded and none of the described conditions to be poor enough to warrant either displacement. It is likely that this group will be satisfied with their experience regardless of the experienced conditions but visit for pristine conditions and would like to see these maintained. Of this group, 72.2% were intercepted at Crescent Lake, 16.7% were intercepted at Silver Salmon Creek, and 11.1% were intercepted at Twin Lakes. The average trip length was 1.33 (SD = 0.77) days or 6.47 (SD = 2.10) hours if less than one day. Respondents reported having visited the parks for 1.67 (SD = 1.33) days in the last five years and for 1.11 (SD = 0.32) years total. Approximately 83.3% were guided. California (22.2%), Alaska (16.7%), Arizona (11.1%), and Washington (11.1%) were the most common places of residence, with 0 international responses. About 88.9% identified as male, 33.3% received a four-year college degree, 33.3% completed some college, 22.2% received a graduate or professional degree, and 11.1% received a two-year college degree. In terms of income, 27.9% reported an annual household income greater than $200,000, and 16.7% reported earning between $150,000 and $199,999. Lastly, 77.8% identified as white, 5.6% each as Hispanic, Black or African American, and Asian. The average age was 46 (SD = 15.47) years old.

Group Three. Group three represents 8% (4 responses) of all responses and consists of those individuals who reported management action should occur at 21% degraded and displacement would occur at 30% degraded. This group places a higher value on environmental conditions than any other group. Members of this group are likely the first to be dissatisfied with their experience due to environmental degradation present. Of this group, 100% were intercepted at Crescent Lake. The average trip length was 1.00 (SD = 0.00) day or 7.50 (SD = 3.11) hours if less than one day. Respondents reported having visited the parks for 3.25 (SD = 1.71) days in the last five years and for 4.50 (SD = 2.65) years total. California (50.0%), Alaska (25.0%), and Hawaii (25.0%) were the only places of residence. All respondents were guided and identified as male, 50.0% received a two-year college degree and 25.0% each received a graduate,

professional degree or a four-year college degree. In terms of income, 25.0% reported an annual household income between $35,000 and $49,999, with the remaining 75% declining to answer. Lastly, 75.0% identified as white and 25.0% identified as Hispanic or Latino/Latina. The average age was 66 (SD = 3.40) years old.

Table 19. *Percent of respondents reporting each level of acceptability for the amount of vegetation degradation surrounding angling sites.*

	Very Unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)
Photo 1 0% degraded	0	0	0	0	4.0	0	0	16.0	80.0	3.68 (0.8)[1]
Photo 2 10% degraded	0	0	0	0	4.0	4.0	10.0	48.0	34.0	3.04 (1.0)[2]
Photo 3 25% degraded	4.0	2.0	2.0	6.0	8.0	6.0	26.0	30.0	16.0	1.80 (2.0)[3]
Photo 4 45% degraded	12.0	6.0	6.0	20.0	4.0	16.0	14.0	10.0	12.0	0.24 (2.6)[4]
Photo 5 70% degraded	20.0	16.0	22.0	6.0	12.0	2.0	4.0	8.0	10.0	-1.04 (2.7)[5]

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings.

Table 20. *Percent of respondents reporting each condition for evaluative dimensions of amount of vegetation degradation surrounding angling sites.*

	0% degraded (1)	10% degraded (2)	25% degraded (3)	45% degraded (4)	70% degraded (5)	None of these conditions	Mean (SD)
Expected	44.0	34.0	8.0	10.0	4.0		2.00 (1.3)
Average Experienced	50.0	26.0	10.0	10.0	4.0		1.92 (1.2)
Management Action	0	2.0	12.0	20.0	36.0	30.0	4.29 (0.9)
Displacement	0	0	6.0	4.0	30.0	60.0	4.60 (0.8)

Note. Highest percentages across rows are highlighted. Means and standard deviations do not include the opt out category of "None of these conditions."

Groups within View at One Time (GAOT)

The acceptability of groups within view at one time (GAOT) was tested using visual methods. Respondents were presented with six computer-manipulated photographs displaying: 0, 2, 4, 6, 8, and 10 groups. GAOT was presented to all respondents NOT selecting angling as the primary activity during their trip, largely bear viewers. Acceptability ratings were statistically different ($p < 0.05$) across parks so unique norm curves were created for KATM and LACL.

For KATM, the condition with the highest reported acceptability was 0 groups within view (M = 3.83). The acceptability then decreased as the number of groups increased, with the steepest slope towards the middle of the curve. Acceptability differed statistically ($p < 0.05$) between all conditions except 6 groups and 8 groups. The largest level of disagreement occurred at 6 groups, which resulted in a PCI_2 value of 0.46. Prior to visiting KATM, respondents expected to see an average of 2.5 groups at one time. Like previous indicators, respondents experienced slightly worse conditions than expected, with an average experienced condition of 2.9 groups at one time, but still well under the threshold of 5.1 groups.

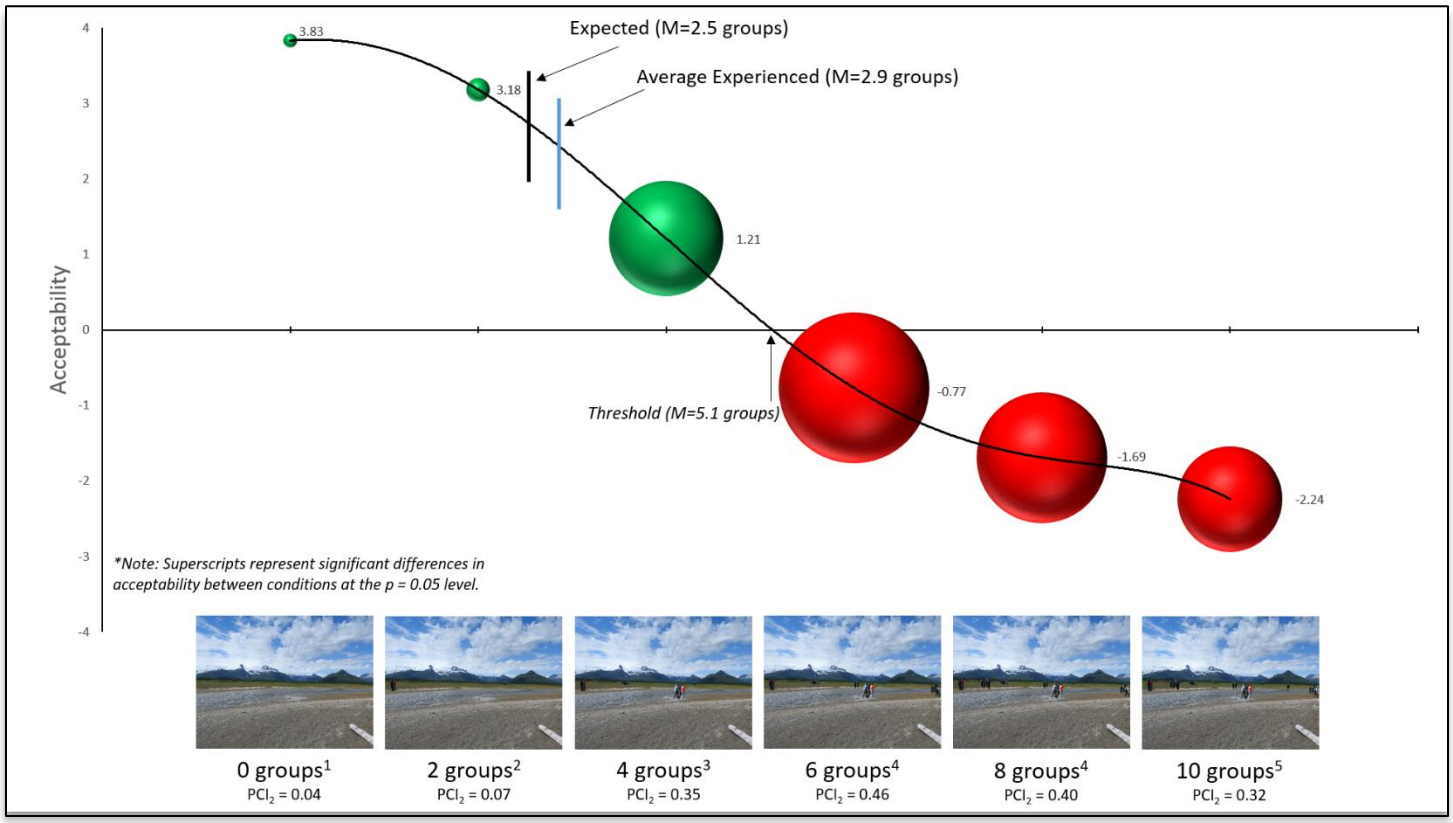


Figure 46. KATM social norm curve for groups within view at one time displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

For LACL, the condition with the highest reported acceptability was 0 groups within view (M = 3.85). The acceptability then decreased as the number of groups increased, with the steepest slope towards the middle of the curve. Acceptability differed statistically between all conditions ($p < 0.05$). The largest level of disagreement occurred at 6 groups, which resulted in a PCI_2 value of 0.49. The subsequent conditions (8 and 10 groups) both resulted in PCI_2 values of 0.43. Prior to visiting LACL, respondents expected to see an average of 2.4 groups at one time. Respondents experienced slightly better conditions than expected, with an average experienced condition of 2.2 groups at one time, well under the threshold of 5.9 groups.

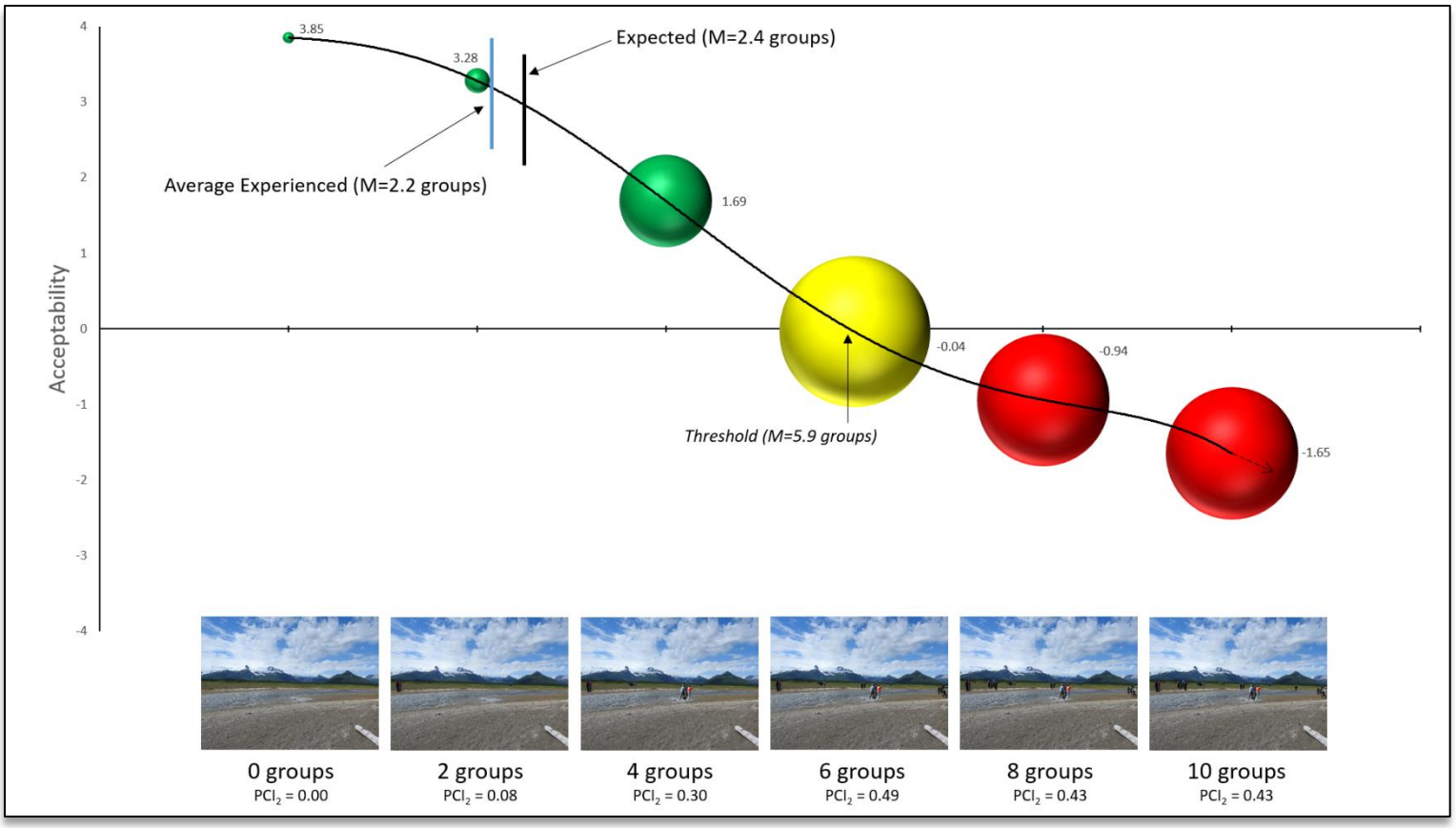


Figure 47. LACL social norm curve for groups within view at one time displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions. Acceptability was statistically different ($p < 0.05$) across all conditions.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

To address the evaluative conditions of management action (the conditions deemed poor enough to warrant management action) and displacement (the conditions deemed poor enough to keep people from visiting), the researchers performed an additional K-means clustering analysis, based on responses for both of these evaluative dimensions. This analysis included responses from both parks in order to maintain an adequate sample size in each of the groups. Four groups were selected: one with neither management action nor displacement and three with various levels of both. These groups were plotted with the condition at which management action should occur on the x-axis and the condition at which displacement would occur on the y-axis (Figure 28). The size of each bubble represents the percent of the sample in that group. This value is also displayed numerically for each group. In the coming descriptions, groups are referred to as groups one, two, three, or four, based on the percent of the sample within each group, with group one being the largest, and group four being the smallest.

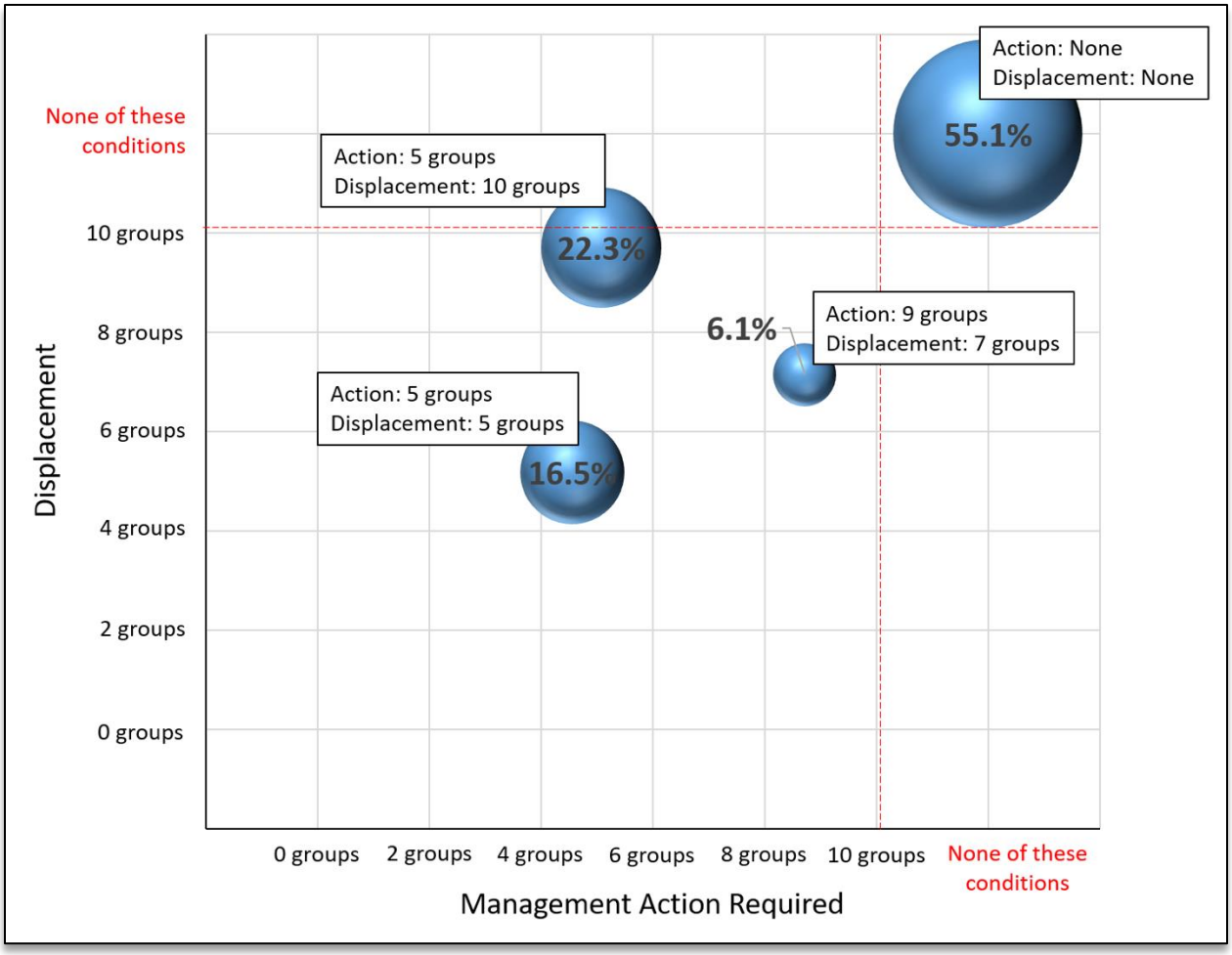


Figure 48. Evaluative dimensions of management action and displacement for groups within view at one time, analyzed using K-means clustering. Percentages represent the percent of the sample in each group. The dashed red lines represent the highest tested condition. Levels higher than this line represent a majority of the group selecting "none of these conditions" as poor enough to warrant either management action or displacement.

Group One. Group one represents 55.1% (254 responses) of all responses and consists of those individuals who reported none of the described conditions to be poor enough to warrant management action or displacement. This group is likely to be satisfied with their experience regardless of experienced conditions. Of this group, 34.6% were intercepted at the King Salmon Airport, 16.9% were intercepted at Hallo Bay, 12.8% were intercepted at Port Alsworth, 11.9% were intercepted at Chinitna Bay, 8.6% were intercepted at Crosswinds Lake, 6.6% were intercepted at Silver Salmon Creek (16 of 24 total Silver Salmon Creek responses), and 2.8% were intercepted at Twin Lakes (7 out of 9 total Twin Lakes responses). The average trip length was 2.70 (SD = 2.66) days or 5.77 (SD = 4.04) hours if less than one day. Respondents reported having visited the parks for 4.06 (SD = 12.74) days in the last five years and for 1.53 (SD = 2.10) years total. Approximately 66.5% were with a guide, 68.5% were bear viewers, 9.0% were backcountry campers and hikers, and 6.3% were photographers. California (9.1%), International (7.6%), Alaska (7.1%), and Colorado (5.9%) were the most common places of residence. About 44.6% identified as male, 43.8% received a graduate or professional degree, 33.5% received a four-year college degree, and 9.4% completed some college. In addition, 24.1% reported an annual household income of $200,000 or greater, 11.2% reported earning between $150,000 and $200,000, and 17.2% reported earning between $100,000 and $150,000. Lastly, 81.5% identified as white, with all other identified races making up 4% (2.4% Asian). The average age was 54 (SD = 15.15) years old.

Group Two. Group two represents 22.3% (103 responses) of all responses and consists of those individuals who reported management action should occur at 5 groups and displacement would occur at 10 groups. This group is the second most tolerant of the four groups. They likely believe conditions begin to be of concern when seeing 5 other groups at a time but are largely accepting of conditions until 10 groups are seen. Of this group, 28.7% were intercepted at the King Salmon Airport, 27.7% were intercepted at Hallo Bay, 15.8% were intercepted at Crosswinds Lake, 13.9% were intercepted at Chinitna Bay, and 8.9% were intercepted at Port Alsworth. The average trip length was 2.71 (SD = 4.70) days or 6.11 (SD = 4.61) hours if less than one day. Respondents reported having visited the parks for 4.44 (SD = 18.77) days in the last five years and for 1.47 (SD = 2.08) years total. Approximately 71.8% were with a guide, 72.8% were bear viewers, 7.8% were backcountry campers and hikers, and 5.8% were photographers. International (16.7%; 6.8% U.K.), California (14.6%), Alaska (12.6%), and Colorado (5.8%) were the most common places of residence. In addition, 53.1% identified as male, 49.0% received a graduate or professional degree, 25.0% received a four-year college degree, 10.4% completed some college, and 8.3% received a high school diploma. Approximately 19.8% reported an annual household income of $200,000 or greater, 10.4% reported earning between $150,000 and $200,000, 16.7% reported earning between $100,000 and $150,000, 18.8% reported earning between $75,000 and $100,000, and 6.3% reported earning between $50,000 and $75,000. Lastly, 74.8% identified as white, with all other identified races making up 9.7% (6.8% Asian). The average age was 51 (SD =15.82) years old.

Group Three. Group three represents 16.5% (76 responses) of all responses and consists of those individuals who reported both management action and displacement should occur at 5 groups within view. This group is likely the least tolerant of degraded conditions and the most likely to

be dissatisfied with their experience. Members of this group also seem to place more weight on the experience of solitude and remoteness than members of other groups. Of this group, 35.6% were intercepted at the King Salmon Airport, 23.3% were intercepted at Crosswinds Lake, 19.2% were intercepted at Hallo Bay, and 9.6% were intercepted at Port Alsworth. The average trip length was 3.71 (SD = 5.34) days or 6.00 (SD = 2.36) hours if less than one day. Respondents reported having visited the parks for 5.38 (SD = 7.48) days in the last five years and for 1.87 (SD 2.52) years total. Additionally, 65.8% were with a guide, 59.2% were bear viewers, 15.8 % were backcountry campers and hikers, and 14.5% were photographers. International (15.8%; 5.3% Netherlands and Switzerland), Alaska (13.2%), and California (11.8%) were the most common places of residence. Approximately 61.0% identified as male, 46.5% received a graduate or professional degree, 34.2% received a four-year college degree, and 6.8% completed some college. In addition, 19.2% reported an annual household income of $200,000 or greater, 9.6% reported earning between $150,000 and $200,000, 21.9% reported earning between $100,000 and $150,000, 8.2% reported earning between $75,000 and $100,000, and 12.3% reported earning between $50,000 and $75,000. Lastly, 89.5% identified as white, with all other identified races making up 3.9% (2.6% American Indian or Alaska Native). The average age was 55 (SD = 12.51) years old.

Group Four. Group four represents 6.1% (28 responses) of all responses and consists of those individuals who reported management action should occur at 9 groups and displacement would occur at 7 groups within view. In terms of tolerance for conditions, this group sits somewhere between groups two and three. However, unlike in previous groups, members of this group report a displacement level sooner than management action would be needed. It is likely that members of this group have a high standard of solitude and remoteness but are aware of the demand for the resource and are willing to go elsewhere. Of this group, 33.8% were intercepted at Hallo Bay, 14.8% were intercepted each at Chinitna Bay, and the King Salmon Airport, and 11.1% were intercepted each at Crosswinds Lake, Port Alsworth, and Silver Salmon Creek. The average trip length was 2.96 (SD = 4.41) days or 6.19 (SD = 5.24) hours if less than one day. Respondents reported having visited the parks for 7.11 (SD = 14.78) days in the last five years and for 1.57 (SD 1.48) years total. Approximately, 78.6% were with a guide, 69.7% were bear viewers, 14.3% were photographers, and 7.1 % were backcountry campers and hikers. International (14.3%; 7.1% U.K. and Switzerland), California, Colorado, Oregon, Indiana, Louisiana, and Michigan (7.1% each) were the most common places of residence. In addition, 52% identified as female, 60.0% received a graduate or professional degree, 20.4% received a four-year college degree, and 16.0% completed some college. Approximately, 20.0% reported an annual household income of $200,000 or greater, 16.0% reported earning between $150,000 and $200,000, 24.0% reported earning between $100,000 and $150,000, 8.2% reported earning between $75,000 and $100,000, and 8.0% reported earning between $25,000 and $35,000. Lastly, 85.7% identified as white and 3.6% identified as Asian. The average age was 56 (SD = 12.59) years old.

Table 21. *Percent of respondents reporting each level of acceptability for groups within view at one time.*

	Park	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*-test
Photo 1	KATM	1.0	0	0	0.3	0	0.3	0.6	4.9	92.9	3.83 (0.9)[1]	$t(465) = -0.2$
0 groups	LACL	0	0	0	0	1.3	0.6	0.6	6.9	90.6	3.85 (0.6)[A]	$p = 0.850$
Photo 2	KATM	0.3	0.6	1.3	1.0	1.0	3.6	5.2	37.7	49.4	3.18 (1.3)[2]	$t(465) = -0.9$
2 groups	LACL	0	1.3	1.3	1.3	0.6	3.8	3.1	28.9	59.7	3.28 (1.3)[B]	$p = 0.393$
Photo 3	KATM	4.5	5.2	5.8	9.4	7.5	11.4	16.9	26.6	12.7	1.21 (2.3)[3]	$t(465) = -2.2$
4 groups	LACL	2.5	4.4	6.3	4.4	4.4	11.3	16.4	36.5	13.8	1.69 (2.1)[C]	$p = 0.030$*
Photo 4	KATM	15.6	17.9	14.9	10.4	5.5	9.1	12.7	11.0	2.9	-0.77 (2.5)[4]	$t(465) = -2.9$
6 groups	LACL	10.1	16.4	6.9	14.5	4.4	13.2	11.3	15.7	7.5	-0.04 (2.6)[D]	$p = 0.004$*
Photo 5	KATM	27.9	24.7	11.4	9.4	2.3	8.4	8.4	6.8	0.6	-1.69 (2.4)[4]	$t(465) = -3.2$
8 groups	LACL	16.4	22.6	9.4	12.6	6.9	9.4	11.3	6.9	4.4	-0.94 (2.5)[E]	$p = 0.001$*
Photo 6	KATM	42.9	20.1	9.7	6.2	4.2	5.5	6.8	3.9	0.6	-2.24 (2.2)[5]	$t(286.7) = -2.5$
10 groups	LACL	32.1	18.2	15.1	6.9	3.1	6.9	8.8	4.4	4.4	-1.65 (2.5)[F]	$p = 0.012$*

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings within parks. *$p < 0.05$.

Table 22. *Percent of respondents reporting each condition for evaluative dimensions of groups within view at one time.*

	Park	0 groups (1)	2 groups (2)	4 groups (3)	6 groups (4)	8 groups (5)	10 groups (6)	None of these conditions	Mean (SD)	*t*-test
Expected	KATM	19.5	47.1	24.7	5.5	2.6	0.6		2.27 (1.0)	$t(465) = 0.5$
	LACL	27.7	37.1	24.5	7.5	2.5	0.6		2.22 (1.1)	$p = 0.636$
Average Experienced	KATM	20.5	36.0	29.5	7.8	4.5	1.6		2.45 (1.1)	$t(465) = 3.2$
	LACL	34.0	28.9	29.6	6.9	0.6	0		2.11 (1.0)	$p = 0.002$*
Management Action	KATM	1.3	4.9	13.4	23.5	16.0	20.3	20.6	4.37 (1.3)	$t(343) = -1.4$
	LACL	0	1.3	10.8	18.4	17.7	16.5	35.4	4.58 (1.1)	$p = 0.154$
Displacement	KATM	0.3	0.7	5.6	14.5	13.5	28.9	36.5	5.00 (1.1)	$t(270) = -0.8$
	LACL	0	0.6	3.8	10.2	10.2	25.5	49.7	5.11 (1.1)	$p = 0.435$

Note. Highest percentages across rows are highlighted. *$p < 0.05$. Means, standard deviations, and *t*-tests do not include the opt out category of "None of these conditions."

Bears Viewed per Hour

The acceptability of bears viewed per hour was tested at 6 different conditions: 0-1, 2-3, 4-5, 6-7, 8-9, and 10-11 bears. Bears viewed per hour was presented to all respondents NOT selecting angling as the primary activity during their trip, largely bear viewers. Acceptability ratings were not statistically different ($p > 0.05$) across parks so one norm curve was created for both parks with park-specific evaluative dimensions. For both parks, both 4-5 and 6-7 bears per hour had the highest reported acceptability (M = 2.31). The acceptability begins relatively neutral at 0.95 for 0-1 bears per hour then increases slowly as the number of bears seen increases before decreasing slightly at 8-9 and 10-11 bears per hour. The largest level of disagreement occurred at both 0-1 and 10-11 bears ($PCI_2 = 0.40$). As with the curve for distance to a focal bear, the acceptability did not cross zero within the conditions tested. To determine the threshold, the researcher solved for the x-intercept using the equation for the trend line. These calculations provided a threshold of 0.1 bears per hour (i.e., 'too few') and again at 17.2 bears per hour (i.e., too many'). It is important to note that these conditions were not tested, but merely extrapolated using the results provided (represented by the dashed line or extension of the trend in the norm curve).

Prior to visiting KATM, respondents expected to see an average of 3.2 bears per hour. Experienced conditions exceeded those expectations, with respondents viewing approximately 4.0 bears per hour on average. Prior to visiting LACL, respondents expected to see an average of 3.0 bears per hour. Experienced conditions were slightly lower than expected, with respondents viewing approximately 2.5 bears per hour on average.

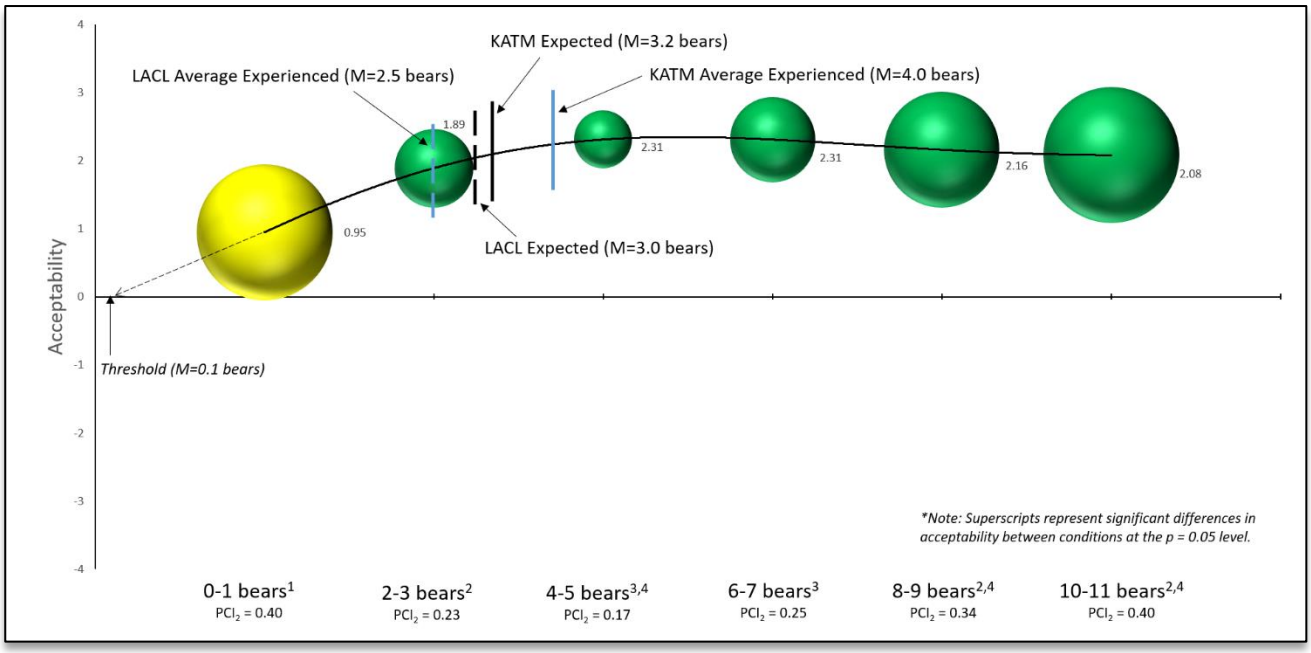


Figure 49. Social norm curve for bears viewed per day displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions (KATM = solid vertical lines; LACL = dashed vertical lines).

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

To address the evaluative conditions of management action (the conditions deemed poor enough to warrant management action) and displacement (the conditions deemed poor enough to keep people from visiting), the researchers performed an additional K-means clustering analysis, based on responses for both of these evaluative dimensions. This analysis included responses from both parks in order to maintain an adequate sample size in each of the groups. Four groups were selected: one with only management action, one with only displacement, and two with various levels of both. These groups were plotted with the condition at which management action should occur on the x-axis and the condition at which displacement would occur on the y-axis. The size of each bubble represents the percent of the sample in that group. This value is also displayed numerically for each group. In the coming descriptions, groups are referred to as groups one, two, three, or four, based on the percent of the sample within each group, with group one being the largest, and group four being the smallest.

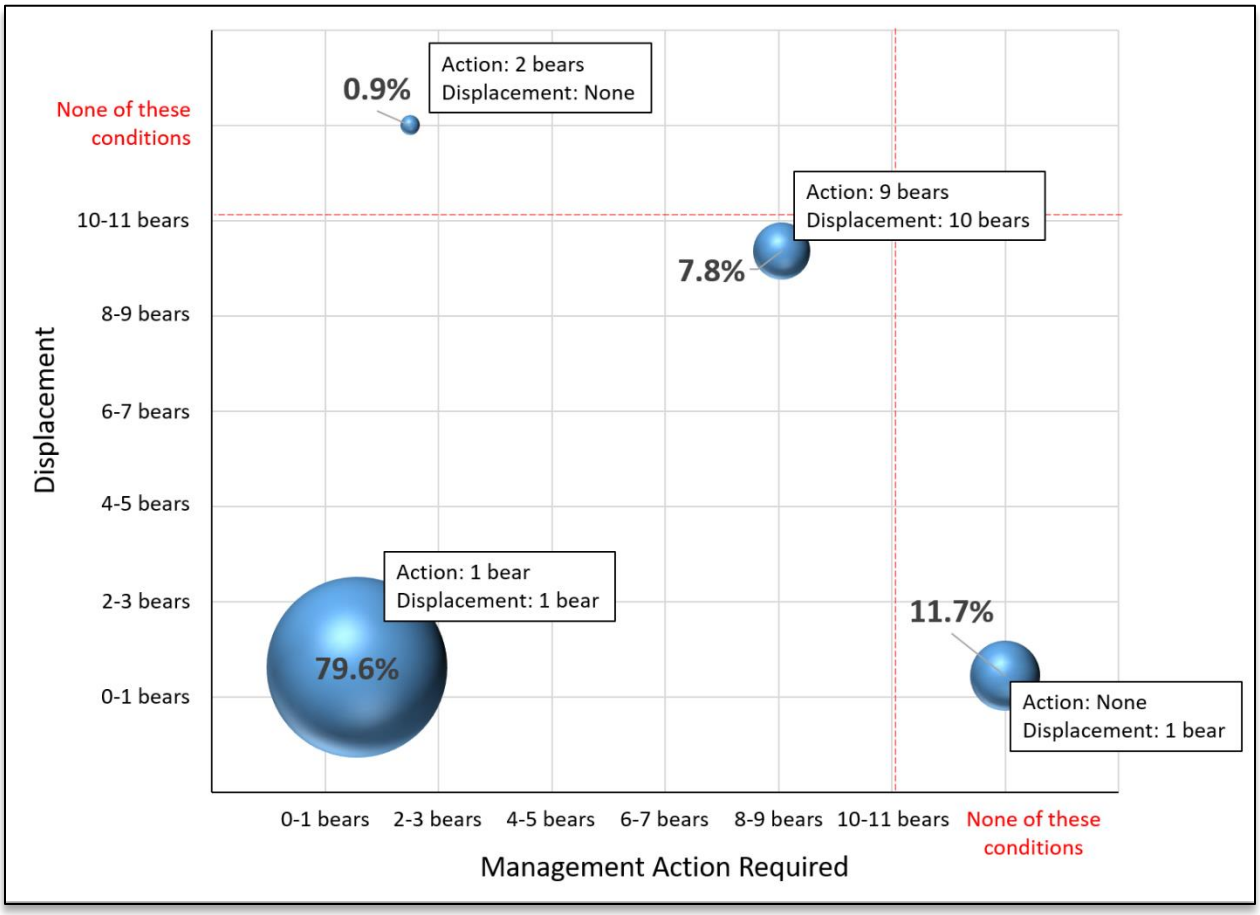


Figure 50. Evaluative dimensions of management action and displacement for bears viewed per hour, analyzed using K-means clustering. Percentages represent the percent of the sample in each group. The dashed red lines represent the highest tested condition. Levels higher than this line represent a majority of the group selecting "none of these conditions" as poor enough to warrant either management action or displacement.

Group One. Group one represents 79.6% (347 responses) of all responses and consists of those individuals who reported both management action and displacement should occur at 1 bear viewed per hour. This group is the most tolerant of experienced conditions and it is likely that they will be satisfied with their experience as long as at least 1 bear is seen. Of this group, 26.5% were intercepted at the King Salmon Airport, 24.4% were intercepted at Hallo Bay, 14.3% were intercepted each at Crosswinds Lake, 12.5% were intercepted at Chinitna Bay, 10.1% were intercepted at Port Alsworth, 5.7% (19 of 24) were intercepted at Silver Salmon Creek, and 1.8% (6 of 9 responses) were intercepted at Twin Lakes. The average trip length was 2.89 (SD = 3.49) days or 5.54 (SD = 3.53) hours if less than one day. Respondents reported having visited the parks for 5.00 (SD = 15.36) days in the last five years and for 1.62 (SD 2.36) years total. Approximately 69.5% were with a guide, 68.9% were bear viewers, 9.5% were backcountry campers and hikers, and 8.9% were photographers. International (14.6%), California (11.0%), Alaska (9.2%), and Colorado (5.2%) were the most common places of residence. In addition, 51.2% identified as male, 44.1% received a graduate or professional degree, 31.8% received a four-year college degree, and 10.9% completed some college. Approximately 22.4% reported an annual household income of $200,000 or greater, 17.7% reported earning between $100,000 and $150,000, 12.1% reported earning between $75,000 and $100,000, and 8.8% reported earning between $50,000 and $75,000. Lastly, 86.2% identified as white with all other identified races making up 5.8% (2.6% Asian). The average age was 54 (SD = 14.58) years old.

Group Two. Group two represents 11.7% (51 responses) of all responses and consists of those individuals who reported displacement would occur at 1 bear viewed per hour but none of these conditions are poor enough to require management action. It is likely that members of this group feel strongly about seeing a bear but believe this cannot be controlled and are understanding if it does not happen. Of this group, 45.8% were intercepted at the King Salmon Airport, 14.6% were intercepted at Port Alsworth, 10.4% were intercepted each at Hallo Bay and Chinitna Bay, and 8.3% were intercepted at Crosswinds Lake. The average trip length was 2.84 (SD = 3.47) days or 7.24 (SD = 6.64) hours if less than one day. Respondents reported having visited the parks for 4.00 (SD = 9.87) days in the last five years and for 1.59 (SD 1.39) years total. Approximately 52.9% were with a guide, 64.7% were bear viewers, 9.8% were photographers, and 7.8% were backcountry campers and hikers. California (9.8%), International (9.8%), Colorado (7.8%), were the most common places of residence. In addition, 59.2% identified as male, 57.1% received a graduate or professional degree, and 26.5% received a four-year college degree. Approximately 22.4% reported an annual household income of $200,000 or greater, 10.2% reported earning between $150,000 and $200,000, and 18.4% reported earning between $100,000 and $150,000. Lastly, 88.2% identified as white and 5.9% identified as Asian. The average age was 55 (SD = 15.85) years old.

Group Three. Group three represents 7.8% (34 responses) of all responses and consists of those individuals who reported management action should occur at 9 bears per hour and displacement would occur at 10 bears viewed per hour. This is the only group reporting levels of either condition greater than 2 bears per hour. The large proportion of this group intercepted at King Salmon and Port Alsworth suggests that members of this group no longer feel safe when viewing more than 9 bears per hour. While less likely, another potential explanation is that members of

this group may feel viewing 9 or 10 bears per hour is no longer natural and begins to feel like a contrived experience. Of this group, 60.6% were intercepted at the King Salmon Airport, 21.2% were intercepted at Port Alsworth, and 9.1% were intercepted at Silver Salmon Creek. The average trip length was 3.65 (SD = 7.52) days or 7.20 (SD = 2.93) hours if less than one day. Respondents reported having visited the parks for 2.94 (SD = 3.58) days in the last five years and for 1.47 (SD 1.33) years total. Approximately 73.5% were with a guide, 52.9% were bear viewers, 17.6% were backcountry campers and hikers, and 5.9% were members of a flightseeing tour. Alaska (14.7%), California (11.8%), and Michigan (8.8%) were the most common places of residence. In addition, 2.9% of these respondents were international, all of which were from Canada. 58.8% identified as female, 52.9% received a graduate or professional degree, 26.5% received a four-year college degree, and 11.8% received a high school diploma. Approximately, 20.6% reported an annual household income of $200,000 or greater, 20.6% reported earning between $100,000 and $150,000, and 17.6% reported earning between $75,000 and $100,000. Lastly, 85.3% identified as white and 2.9% identified as Asian. The average age was 52 (SD = 15.28) years old.

Group Four. Group four represents 0.9% (4 responses) of all responses and consists of those individuals who reported management action should occur at 2 bears viewed per hour but none of these conditions are poor enough to warrant displacement. It is likely that this group is the most understanding of the standard risks in wildlife viewing (i.e., not seeing desired wildlife) but believes the remoteness of such a location demands a high return on investment, with 2 or more bears viewed per hour. Of this group, 66.7% were intercepted at the King Salmon Airport and 33.3% were intercepted at Port Alsworth. The average trip length was 2.25 (SD = 1.89) days or 17.00 (SD = 9.90) hours if less than one day. Respondents reported having visited the parks for 2.25 (SD = 1.89) days in the last five years and for 1.00 (SD 0.00) years total. Half of this group traveled with a guide, 75.0% were bear viewers, and 25% were backcountry campers and hikers. California (50.0%), Alaska (25.0%), and Colorado (25.0%) were the most common places of residence. Seventy-five percent identified as male, 50.0% received a graduate or professional degree, and 50.0% received a four-year college degree. Fifty percent reported an annual household income of between $100,000 and $150,000 and 50.0% reported earning between $75,000 and $100,000. Lastly, 75.0% identified as white and 25.0% identified as Asian. The average age was 56 (SD = 19.82) years old.

Table 23. *Percent of respondents reporting each level of acceptability for bears viewed per hour.*

	Park	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*-test
0-1 bears	KATM	5.9	6.6	9.3	8.0	14.5	8.3	6.9	19.7	20.8	0.94 (2.6)[1]	$t(439) = -0.04$
	LACL	9.9	6.6	5.9	5.9	13.8	9.2	5.3	21.1	22.4	0.95 (2.7)[A]	$p = 0.972$
2-3 bears	KATM	2.8	2.4	5.9	5.5	12.8	5.9	12.1	27.3	25.3	1.78 (2.2)[2]	$t(439) = -1.5$
	LACL	1.3	2.6	2.6	3.9	13.8	7.9	10.5	25.7	31.6	2.10 (2.0)[B]	$p = 0.132$
4-5 bears	KATM	1.7	2.1	3.1	2.8	11.4	9.7	8.0	25.3	36.0	2.23 (2.0)[3,4]	$t(439) = -1.1$
	LACL	0	2.6	3.3	3.3	9.2	7.2	9.9	22.4	42.1	2.45 (1.9)[C,D]	$p = 0.279$
6-7 bears	KATM	3.1	3.1	4.2	4.5	10.7	3.5	5.5	19.4	46.0	2.22 (2.3)[3]	$t(439) = -1.2$
	LACL	1.3	2.6	3.9	2.0	11.2	5.9	5.9	14.5	52.6	2.49 (2.1)[C]	$p = 0.242$
8-9 bears	KATM	5.5	6.2	3.5	2.1	10.7	2.8	2.8	17.3	49.1	2.07 (2.6)[2,4]	$t(439) = -1.0$
	LACL	3.9	3.3	1.3	5.3	11.8	3.9	3.3	12.5	54.6	2.33 (2.4)[B,D]	$p = 0.309$
10-11 bears	KATM	8.7	6.6	1.0	2.8	11.1	2.1	1.0	11.5	55.7	2.01 (2.8)[2,4]	$t(439) = -0.8$
	LACL	6.6	3.9	2.6	3.9	10.5	2.6	2.0	7.9	59.9	2.22 (2.7)[B,D]	$p = 0.443$

Note. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings within parks.

Table 24. *Percent of respondents reporting each condition for evaluative dimensions of bears viewed per hour.*

	Park	None of these conditions	0-1 bears (1)	2-3 bears (2)	4-5 bears (3)	6-7 bears (4)	8-9 bears (5)	10 -11 bears (6)	Other	Mean (SD)	*t*-test
Expected	KATM		27.2	33.1	19.9	7.3	4.2	3.1	5.2	2.34 (1.3)	$t(414) = 0.8$
	LACL		31.6	31.6	18.4	7.9	1.3	3.9	5.3	2.24 (1.3)	$p = 0.420$
Average Experienced	KATM		30.0	16.7	19.2	12.2	8.4	8.0	5.6	2.75 (1.6)	$t(371.2) = 5.4$
	LACL		42.8	23.0	17.8	5.3	3.9	0.7	6.6	2.00 (1.2)	$p < 0.001$*
Management Action	KATM	59.3	17.5	4.6	6.0	3.2	3.2	6.3		2.72 (1.9)	$t(95.6) = -1.6$
	LACL	63.6	14.6	1.3	2.6	5.3	2.6	9.9		3.27 (2.1)	$p = 0.106$
Displacement	KATM	64.9	24.2	1.4	3.2	1.8	1.1	3.5		1.99 (1.7)	$t(142) = -0.9$
	LACL	70.9	18.5	2.0	1.3	0.7	2.0	4.6		2.30 (2.0)	$p = 0.347$

Note. Highest percentages across rows are highlighted. *$p < 0.05$. Means, standard deviations, and *t*-tests do not include opt out categories of "None of these conditions" or "Other."

Impact of Current Conditions on Experience Quality

After responding to the acceptability and evaluative dimensions for each indicator, as detailed above, respondents were asked to rate the impact of the experienced condition for each indicator on overall experience quality. In other words, researchers wanted to know how current conditions influenced the quality of a visit? These ratings used a five-point Likert scale, with 1 being extremely decreased, 3 being neither increased nor decreased, and 5 being extremely increased. Respondents were only asked to rate impacts for the indicators they were presented. In general, experienced conditions either increased or had little effect on experience quality. No average impact rating was lower than the neutral point (3 on the scale), suggesting that the experienced conditions of all tested indicators at least slightly improved the visitor experience.

For KATM, groups encountered per day received the lowest average rating at 2.81, meaning the average experienced number of groups slightly decreased the quality of the experience. The number of bears viewed per hour received the highest average rating at 4.01, meaning the average number of bears viewed per hour significantly increased the quality of the experience. Ratings for this indicator as well as distance to a bear were statistically higher than all other indicators ($p < 0.05$). The next highest rating came from groups within view (M = 3.47), followed by anthropogenic sound per hour (M = 3.34), then fish caught with previous scarring (M = 3.10), all of which were statistically different ($p < 0.05$).

For LACL, groups encountered per day received the lowest average rating at 3.12, meaning the average experienced number of groups very slightly increased the quality of the experience. The amount of vegetation degradation received the highest average rating at 3.80, meaning the average amount of vegetation degradation experienced increased the quality of the experience. Ratings for this indicator were statistically higher than the amount of anthropogenic sound heard, and the number of groups encountered per day ($p < 0.05$). The second-highest rating came from distance to a bear (M = 3.77), followed by groups within view (M = 3.69), bears viewed per hour (M = 3.59), then anthropogenic sound per hour (M = 3.25), all of which were statistically different ($p < 0.05$).

Table 25. *Impact of average experienced condition for each indicator on overall experience quality.*

Indicator	Park	Average experienced condition	Extremely decreased (1)	(2)	Neither increased nor decreased (3)	(4)	Extremely increased (5)	Mean (SD)	*t*-test
Distance to a bear	KATM	21.55 yards	1.0	1.7	30.1	32.0	35.2	3.99 (0.9)[1]	$t(387.9) = 2.7$ $p = 0.008$*
	LACL	24.25 yards	3.7	4.2	31.3	33.2	27.6	3.77 (1.0)[A]	
Anthropogenic sound per hour	KATM	13.01 min	0.8	12.2	56.2	13.7	17.1	3.34 (0.9)[3]	$t(586) = 1.1$ $p = 0.268$
	LACL	14.5 min	3.0	11.4	56.4	15.8	13.4	3.25 (0.9)[C]	
Groups encountered per day	KATM	4.95 groups	2.9	24.8	64.8	3.8	3.8	2.81 (0.7)[5]	$t(153) = -2.4$ $p = 0.019$*
	LACL	3.90 groups	2.0	16.0	58.0	16.0	8.0	3.12 (0.8)[C]	
Groups within view	KATM	2.90 groups	1.0	5.5	57.3	18.2	17.9	3.47 (0.9)[2]	$t(463) = -2.5$ $p = 0.012$*
	LACL	2.22 groups	1.9	3.2	44.3	25.3	25.3	3.69 (1.0)[A,B]	
Bears viewed per hour	KATM	4.00 bears	1.4	1.7	30.3	27.5	39.0	4.01 (0.9)[1]	$t(437) = 4.394$ $p < 0.001$*
	LACL	2.50 bears	2.6	6.6	38.8	32.9	19.1	3.59 (1.0)[B]	
Scarred fish caught per day	KATM	2.00 fish	2.0	5.9	78.2	7.9	5.9	3.10 (0.7)[4]	
Vegetation degradation	LACL	9.2%	2.0	16.0	58.0	16.0	30.0	3.80 (0.9)[A,B]	

Note. Levels of impact are listed as percent of the sample. Highest percentages across rows are highlighted. Superscripts in Mean column represent statistically significant differences ($p < 0.05$) in acceptability ratings within parks. *$p < 0.05$.

Visitors intercepted at different locations represent different populations, often with different normative thresholds. Similarly, the impact of each of these standards on experience quality may vary across locations. For all indicators, except fish caught with previous scarring and vegetation degradation, mean levels of impact differed statistically ($p < 0.05$) between intercept locations.

Regarding distance to a bear, respondents from Hallo Bay (M = 4.36) reported a statistically greater positive impact for the conditions they experienced than all other sites. Respondents from Port Alsworth (M = 3.34) reported a statistically lower impact than all other sites but still above the neutral point. For anthropogenic sound per hour, respondents intercepted at Hallo Bay (M = 3.58) reported a statistically greater positive impact on experience quality than those intercepted at Chinitna Bay (M = 2.96).

For groups encountered per day, respondents intercepted at Crescent Lake reported a statistically more positive impact (M = 3.12) than those intercepted at Crosswinds Lake (M = 2.69), with averages at Crosswinds Lake and Hallo Bay being below 3.0 ("Neither increased nor decreased"). Regarding the number of fish caught per day with previous scarring, none were statistically different, but Hallo Bay respondents reported a mean rating of 2.50, the only of the three applicable locations with a mean lower than 3.0. However, the sample size for anglers at Hallo Bay was critically low (n = 2), meaning results from Hallo Bay for this indicator, as well as groups within view at one time, are not representative of true visitor opinions. For vegetation degradation surrounding angling sites, none were statistically different, but those intercepted at Upper Twin Lakes reported more positive impacts on experience quality (M = 4.50) than did those intercepted at Silver Salmon Creek (M = 4.00) and Crescent Lake (M = 3.74).

For groups within view at one time, respondents from Port Alsworth (M = 4.14) reported a statistically greater positive impact than those from Chinitna Bay, Crescent Lake, Crosswinds Lake, Hallo Bay, and the King Salmon Airport. Again, it is important to note that the low sample size of anglers at Hallo Bay means results may not be representative of true visitor opinions. Lastly, the number of bears viewed per hour resulted in the greatest positive impact at Hallo Bay (M = 4.52), followed by Crosswinds Lake (M = 4.17), then Chinitna Bay (M = 3.73). The lowest positive impact came from visitors intercepted at the King Salmon Airport (M = 3.65), Port Alsworth (M = 3.35), and Silver Salmon Creek (M = 3.46).

Only three indicators at a total of three sites resulted in an impact rating of less than 3.0. This means that experienced conditions regarding anthropogenic sound at Chinitna Bay (M = 2.96), fish caught with previous scarring at Hallo Bay (M = 2.50), and groups encountered per day at Crosswinds Lake (M = 2.96) and Hallo Bay (M = 2.50) all resulted in slightly negative impacts on the quality of the experience.

Table 26: *Mean (SD) score for the impact of experienced condition on overall experience quality, by intercept location.*

	Chinitna Bay	Crescent Lake	Crosswinds Lake	Hallo Bay	King Salmon Airport	Port Alsworth	Silver Salmon Creek	Upper Twin Lakes
Distance to a bear	3.80 (1.1)[2,3]	3.92 (1.1)[1,2]	4.01 (0.9)[1,2]	4.36 (0.8)[1]	3.75 (0.9)[2,3]	3.34 (0.7)[3]	4.07 (1.0)[1,2]	3.89 (0.6)
Anthropogenic sound per hour	2.96 (0.8)[2]	3.19 (0.8)	3.27 (0.8)	3.58 (1.0)[1]	3.31 (1.0)	3.53 (1.0)	3.28 (1.0)	3.33 (0.5)
Groups encountered per day		3.12 (0.8)[1]	2.69 (0.6)[2]	2.50 (0.7)	3.22 (1.0)		3.00 (1.2)	3.50 (0.7)
Fish caught with previous scarring			3.16 (0.7)	2.50 (0.7)	3.39 (1.2)			
Vegetation Degradation		3.74 (1.0)					4.00 (1.0)	4.50 (0.7)
Groups within view	3.43 (1.0)[2]	3.21 (0.8)[2]	3.31 (0.8)[2]	3.43 (0.9)[2]	3.54 (0.9)[2]	4.14 (0.9)[1]	3.56 (0.9)	4.14 (0.7)
Bears viewed per hour	3.73 (1.0)[2,3]	3.85 (1.1)	4.17 (0.9)[1,2]	4.52 (0.6)[1]	3.65 (1.0)[3]	3.35 (0.8)[3]	3.46 (1.1)[3]	3.57 (0.8)

Note. Superscripts represent statistically significant differences ($p < 0.05$) in impact ratings between sites.

For impact, 1 = extremely decreased, 3 = neither increased nor decreased, 5 = extremely increased.

ANALYSIS BY INTERCEPT LOCATION

Accuracy of Reported Locations • **Normative Thresholds**

Analysis by Intercept Location

Through more specific analysis, differences between visiting populations can be further understood and some management objectives can be defined at a smaller spatial.

Accuracy of Visitor Reported Locations

Due to some respondents seemingly challenged with reporting the specific park locations they visited, a check of accuracy was performed by comparing the intercept location recorded by the researchers with the locations respondents reported visiting. Intercepts at the King Salmon Airport or Port Alsworth were not included because these were not options when completing the questionnaire. However, 84% of visitors intercepted at King Salmon airport that were eligible and participated in the study, reported visiting the Valley of Ten Thousand Smokes (approximately 60% of visitors to the Valley of Ten Thousand Smokes also visited Brooks Camp). Across both parks, 76.2% of visitors were able to accurately select the location where they were intercepted. In KATM, only 66.4% of visitors were able to do so, with accuracy higher for Crosswinds Lake than for Hallo Bay (74.2% vs. 57.8%). Respondents to the LACL survey were more accurate (93.7% overall) potentially due to differences in involvement in trip planning and trip objectives, although the exact causes are unknown. Many LACL survey respondents reported ‘park collecting’ as their main activity and potentially had greater control over the locations visited, via lodge stays or charter flights, as opposed to fully guided bear viewing or angling trips common at Crosswinds Lake and Hallo Bay.

Table 27. *Accuracy of visitor-reported locations*

Intercept Location	Intercepted	Reported	Percent accuracy
Crosswinds Lake	151	112	74.17
Hallo Bay	135	78	57.78
KATMAI TOTAL	286	190	66.43
Chinitna Bay	52	48	92.31
Crescent Lake	67	63	94.03
Silver Salmon Creek	31	29	93.55
Upper Twin Lakes	9	9	100
LAKE CLARK TOTAL	159	149	93.71
TOTAL	445	339	76.18

One could posit that a potential logical explanation for the differences seen in accuracy could be the demographics of visitors to these different locations. However, age, gender, and racial or ethnic distributions were approximately equal across all intercept sites and sites with primarily bear viewers (Chinitna Bay, Hallo Bay, Silver Salmon Creek) were no more or less accurate than those with primarily anglers (Crescent Lake, Crosswinds Lake, Upper Twin Lakes). As a result, gender, age, and activity do not seem to influence accuracy of locations. Further, while variation between sites was demonstrated in terms of education levels and income, these results do little to explain the variation in location accuracy. For more detailed results, see the Demographics section earlier in the report.

An additional explanation for the differences in accuracy could be the past use history (i.e., quantification of previous visits) of visitors to these different locations. These results, while not necessarily statistically significant, suggest that differences in accuracy between visitors to Crosswinds Lake and Hallo Bay, as well as between visitors to KATM and LACL, may be, in part, a result of the amount of time spent at the site, particularly during the current trip. The longer a visitor spends at a particular site, the more likely they are to accurately recall the location. For more detailed results, see the Past Use History section earlier in the report.

Justification for Comparing Responses across Intercept Sites

Due to the level of error in visitor-reported locations and the factors explained below, the research team chose to use the intercept location as opposed to the visitor reported location. Further complicating the ability to compare results across visitor reported locations, as opposed to intercept locations, is that 51% of visitors at KATM reported visiting multiple sites and approximately 30% of visitors to LACL reported visiting multiple sites. Consequently, it is unclear which visitors should be included in site comparisons because it is difficult to determine the specific sites that may have a) most influenced visitor responses to questions about the conditions they experienced, b) contributed most or least to their reported perceptions of crowding (or lack thereof), c) represented the majority of their total visit time in the park, or d) been accurately reported by visitors. The additional complication is that if researchers included respondents that visited multiple sites in the analysis, the procedure would frequently include a single visitor more than once in the analysis, potentially inflating error and correlating response patterns (i.e., lack of independence among responses). Removing these multiple site visitors and further segmenting the sample by respondents who only visited one site often creates a relatively low sample size for some less-visited sites reported by visitors (e.g., Kukaklek Lake at KATM). The implication is that the statistical analysis comparing results between visitor reported sites may be hampered by a lack of sensitivity, response variability, and representativeness, which may decrease our ability to detect statistical differences in responses even though a difference may exist (i.e., a Type 2 statistical error). These multiple points of error and lack of clarity underpin the reason that the research team opted to compare questionnaire responses across intercept locations as opposed to visitor reported locations. Ultimately, comparing responses across intercept locations is the more accurate and conservative approach. All differences described as statistical differences represent a p-value less than 0.05. Trends were plotted using IBM's statistical package, SPSS.

Normative Thresholds

Individual Distance to a Focal Bear

The acceptability of viewing a bear at 10 yards was highest at Hallo Bay (M = 2.63) followed by Silver Salmon Creek (M = 1.41), while visitors intercepted at the King Salmon Airport (M = -0.89) and Port Alsworth (M = -1.02) reported negative levels of acceptability. As distance increased to 50 yards, acceptability evened out at high levels across locations. However, beginning at 75 yards, visitors intercepted at Hallo Bay (M = 0.50) and Silver Salmon Creek (M = 0.83) report lower levels of acceptability while those intercepted at the King Salmon Airport

(M = 2.34) and Port Alsworth (M = 2.16) report higher levels of acceptability. Further, both low- and high-end thresholds were at further distances at the King Salmon Airport and Port Alsworth and closer distances at Hallo Bay and Silver Salmon Creek than all other sites. In areas with farther thresholds, expected and experienced distances were further as well.

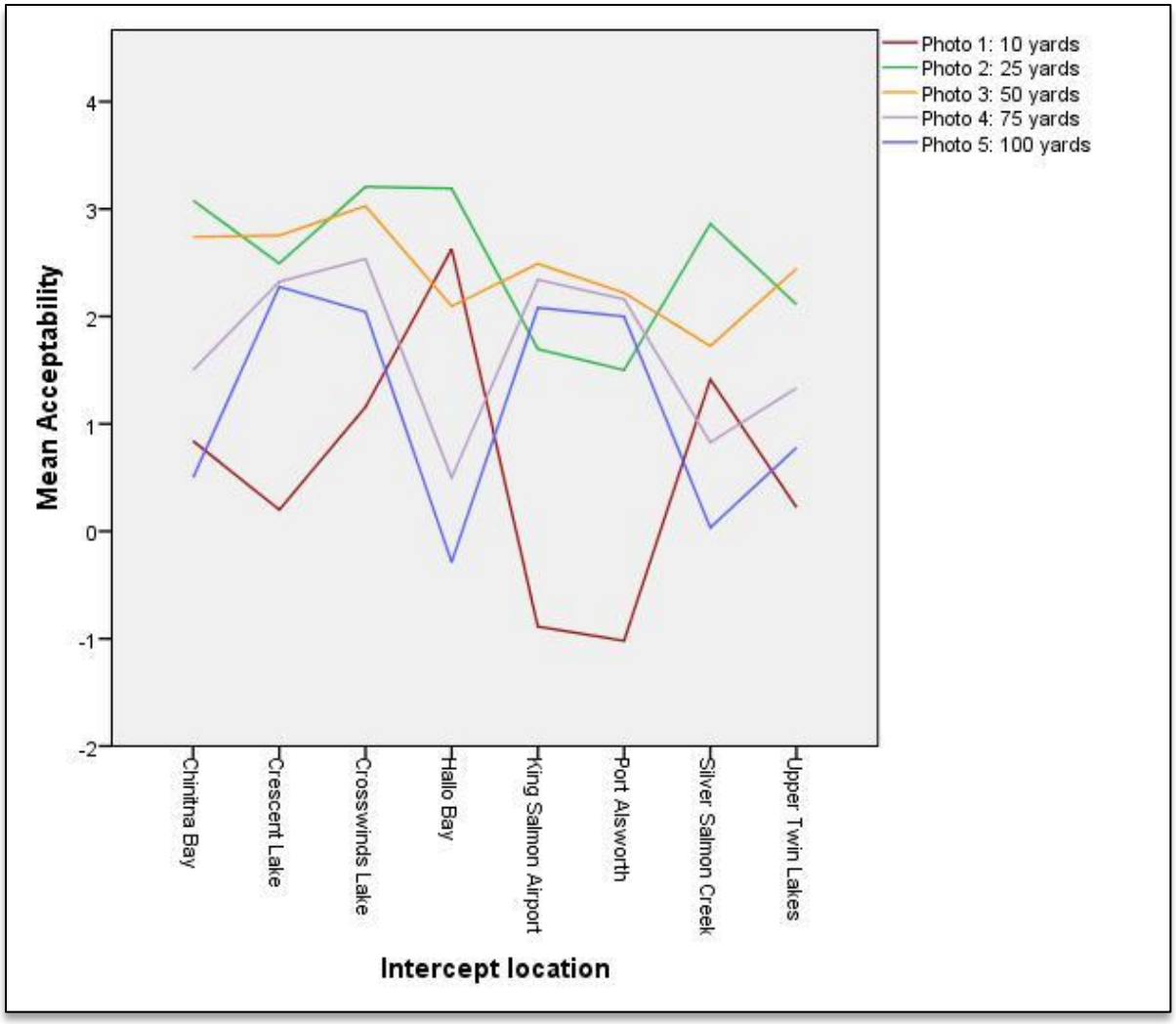


Figure 51. Mean level of acceptability for each presented condition in regard to distance to a focal bear.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 28. *Mean (SD) level of acceptability for individual distances to a bear, by intercept location*

	Photo 1 (10 yards)	Photo 2 (25 yards)	Photo 3 (50 yards)	Photo 4 (75 yards)	Photo 5 (100 yards)	Threshold (yards)	Average Expected (yards)	Average Experienced (yards)
Chinitna Bay	0.84 (3.3)[2]	3.08 (1.3)[1]	2.74 (1.2)	1.50 (2.3)	0.50 (2.9)[2,3]	8.2, 232.5	24.1[2,3]	27.1[1,2]
Crescent Lake	0.20 (2.8)[2,3]	2.49 (1.9)	2.75 (1.8)	2.32 (2.5)[1]	2.28 (2.8)[1,2]	9.5, 471.2	25.5[2,3]	19.5[2,3]
Crosswinds Lake	1.16 (2.5)[2]	3.21 (1.1)[1]	3.03 (1.8)[1]	2.54 (2.4)[1]	2.04 (2.9)[1,2]	7.6, 126.5	21.4[3]	20.1[2,3]
Hallo Bay	2.63 (1.8)[1]	3.19 (1.4)[1]	2.1 (2.3)[2]	0.50 (2.9)[3]	-0.29 (3.3)[3]	1.2, 85.2	20.7[3]	18.1[3]
King Salmon Airport	-0.89 (2.9)[3]	1.70 (2.4)[2]	2.49 (1.9)	2.34 (2.4)[1,2]	2.08 (2.9)[1]	13.9	34.3[2]	27.3[1]
Port Alsworth	-1.02 (2.7)[3]	1.50 (2.6)[2]	2.22 (2.2)	2.16 (2.4)[1,2]	2.00 (2.8)[1,2]	14.5, 220.8	47.5[1]	40.5[1]
Silver Salmon Creek	1.41 (3.0)[1,2]	2.86 (1.7)	1.72 (2.4)[2]	0.83 (3.0)[2,3]	0.03 (3.3)[3]	7.5, 100.4	21.4[3]	25.9
Upper Twin Lakes	0.22 (3.1)	2.11 (1.8)	2.44 (1.1)	1.33 (2.9)	0.78 (3.5)	9.0	36	22.0

Note. For instances when the norm curve crossed the x-axis (i.e., threshold) multiple times, both thresholds are listed. The first threshold represents a lower limit; below which conditions are seen as unacceptable. The second threshold represents an upper limit; above which conditions are seen as unacceptable. Superscripts represent statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Anthropogenic Sound Heard per Hour

The acceptability of hearing 0 minutes of anthropogenic sound per hour was equally high across all intercept locations (M = 2.88). At 15 minutes per hour, acceptability was statistically higher at Silver Salmon Creek (M = 1.52) than at Hallo Bay (M = -0.27). Acceptability at Hallo Bay remains statistically lower for each subsequent condition, joined by that at Crosswinds Lake for 45 and 60 minutes, and at the King Salmon Airport for 45 minutes. Silver Salmon Creek and Crescent Lake report statistically higher acceptability than other sites for 30 minutes, but as conditions worsen, only Crescent Lake reports statistically higher acceptability values. The threshold was highest at Upper Twin Lakes (28.4) and Silver Salmon Creek (27.1) and lowest at Hallo Bay (13.5). Expected conditions did not differ statistically across sites, but the average experienced condition was statistically higher at the King Salmon Airport (M = 15.9) than at Hallo Bay (M = 9.9).

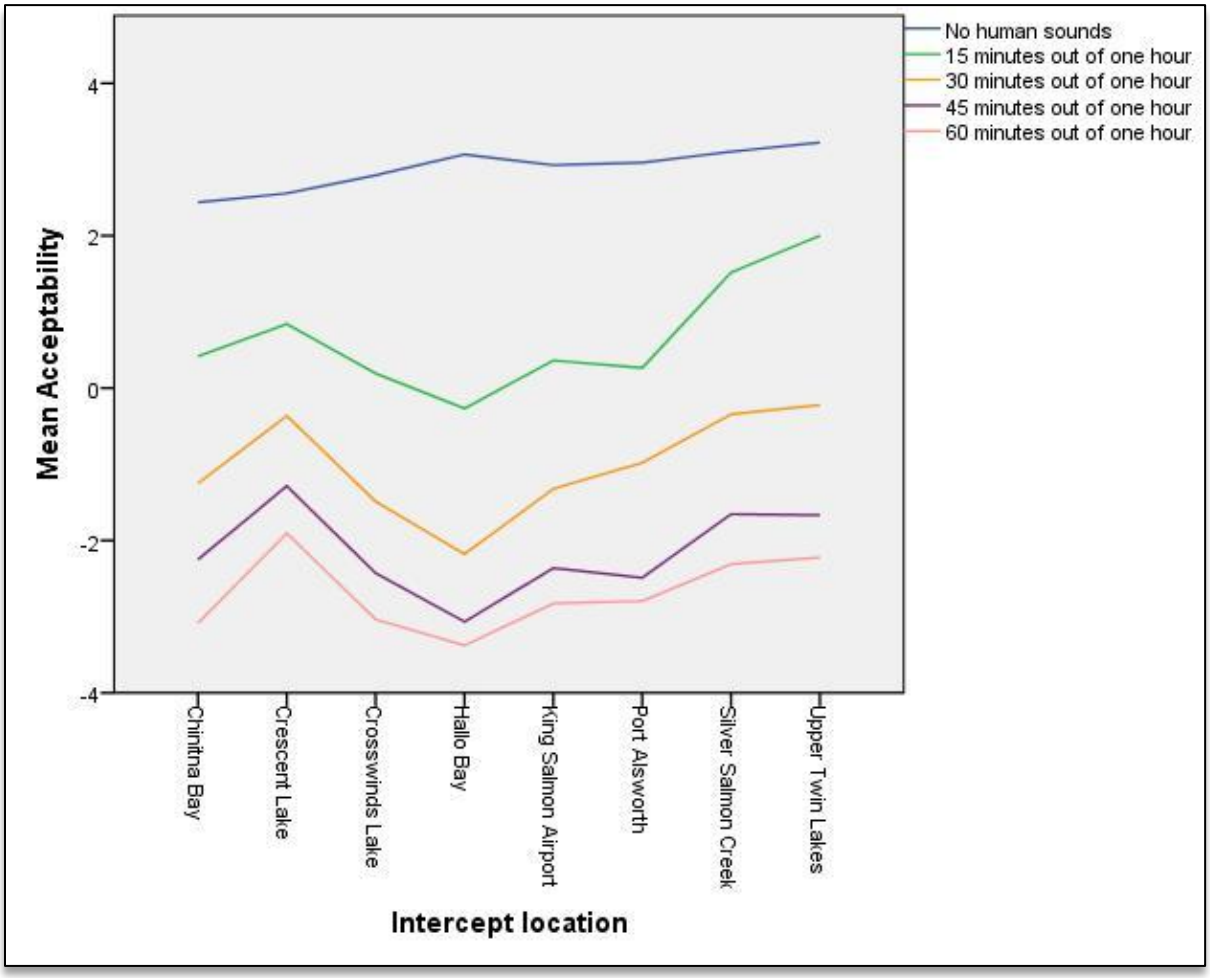


Figure 52. Mean level of acceptability for each presented condition in regard to distance to anthropogenic sound heard per hour.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 29. *Mean (SD) level of acceptability for anthropogenic sound heard per hour, by intercept location.*

	0 minutes	15 minutes	30 minutes	45 minutes	60 minutes	Threshold (minutes)	Average Expected (minutes)	Average Experienced (minutes)
Chinitna Bay	2.44 (2.2)	0.42 (2.2)	-1.25 (2.4)	-2.25 (2.2)	-3.08 (1.8)	18.3	10.9	15.8
Crescent Lake	2.56 (2.0)	0.84 (2.4)	-0.37 (2.5)[1]	-1.29 (2.5)[1]	-1.90 (2.5)[1]	24.9	13.4	15.1
Crosswinds Lake	2.79 (2.0)	0.19 (2.4)	-1.49 (2.3)	-2.43 (1.9)[2]	-3.04 (1.8)[2]	16.4	11.3	12.1
Hallo Bay	3.07 (2.0)	-0.27 (2.5)[2]	-2.18 (2.0)[2]	-3.07 (1.6)[2]	-3.38 (1.5)[2]	13.5	10.4	9.9[2]
King Salmon Airport	2.93 (2.2)	0.36 (2.6)	-1.32 (2.2)	-2.36 (2.0)[2]	-2.83 (2.1)	17.7	14.2	15.9[1]
Port Alsworth	2.96 (2.2)	0.27 (2.6)	-0.98 (2.4)	-2.49 (1.9)	-2.80 (2.3)	18.1	11.9	12.9
Silver Salmon Creek	3.10 (2.0)	1.52 (2.0)[1]	-0.34 (2.4)[1]	-1.66 (2.6)	-2.31 (2.5)	27.1	14.4	14.7
Upper Twin Lakes	3.22 (2.0)	2.00 (1.9)	-0.22 (2.4)	-1.67 (2.8)	-2.22 (3.0)	28.4	16.1	14.2

Note. Superscripts represent statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Groups Encountered per Day

As mentioned previously, this indicator was only provided to respondents selecting angling as the primary activity during their trip. Acceptability of groups encountered per day did not differ statistically across locations at any condition, but respondents intercepted at Hallo Bay reported the highest acceptability for no other groups (M = 4.00) and the lowest acceptability for 12 groups (M = -4.00) and 15 groups (M = -4.00). In general, respondents intercepted at Silver Salmon Creek reported the highest acceptability as conditions worsened. Acceptability was rated as 0.80 for 6 groups, -0.60 for 9 groups, -1.80 for 12 groups, and -2.00 for 15 groups. The threshold was highest at Silver Salmon Creek (7.7) and lowest at Hallo Bay (4.4). The expected condition did not differ statistically across groups, but the average experienced condition was statistically higher at Hallo Bay (M = 9.0) than at Upper Twin Lakes (M = 0.0).

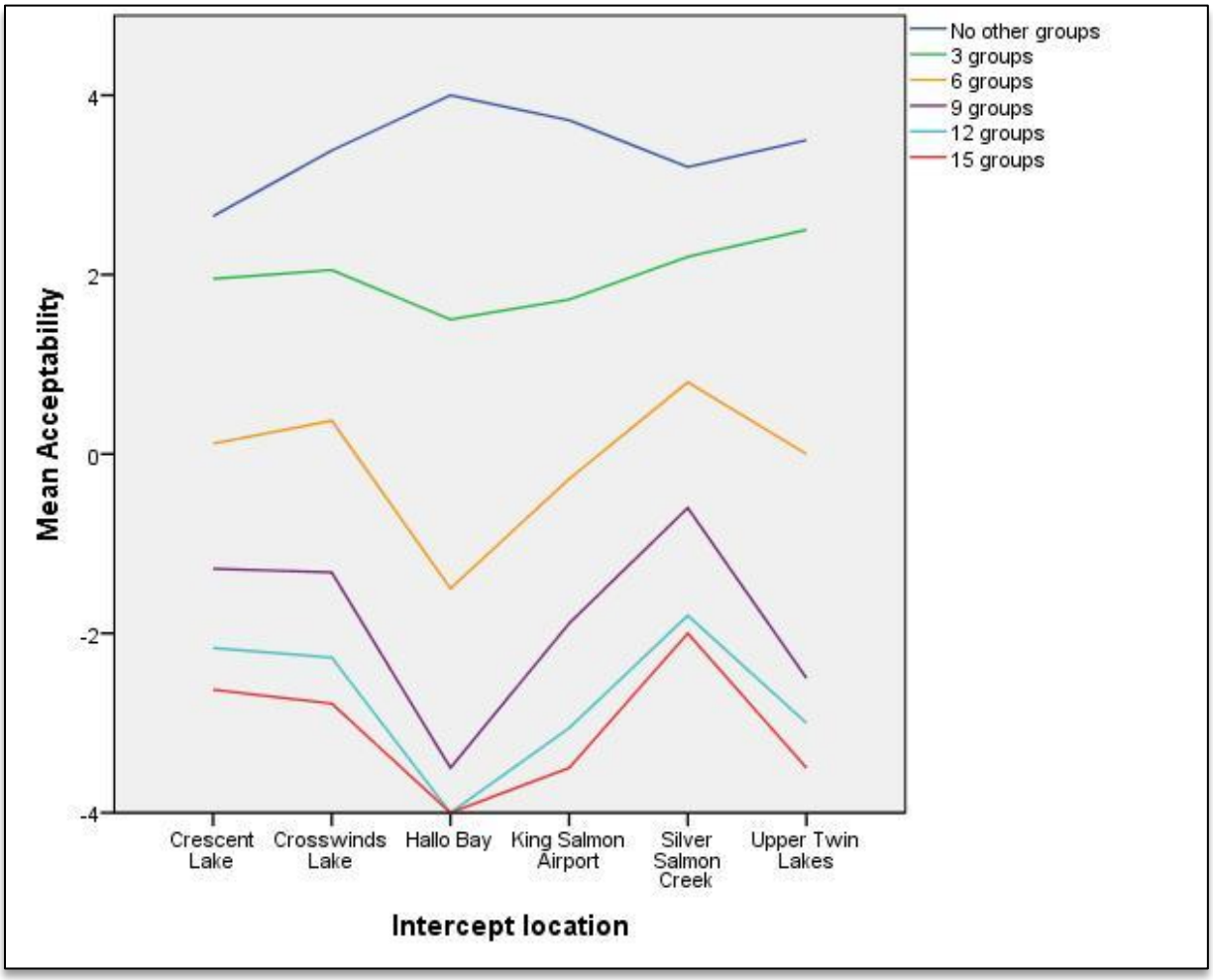


Figure 53. Mean level of acceptability for each presented condition in regard to groups encountered per day.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 30. *Mean (SD) level of acceptability for groups encountered per day, by intercept location. Listed as percent of sample. Superscripts represent statistically significant differences at the p = 0.05 level.*

	No other groups	3 groups	6 groups	9 groups	12 groups	15 groups	Threshold (groups)	Average Expected (groups)	Average Experienced (groups)
Crescent Lake	2.65 (2.4)	0.60 (3.1)	0.12 (2.1)	-1.28 (2.5)	-2.16 (2.4)	-2.63 (2.3)	6.2	4.2	3.9
Crosswinds Lake	3.38 (1.6)	1.95 (1.7)	0.37 (2.4)	-1.32 (2.3)	-2.27 (2.1)	-2.78 (2.0)	6.1	3.5	4.9
Hallo Bay	4.00 (0.0)	2.05 (1.9)	-1.50 (0.7)	-3.50 (0.7)	-4.00 (0.0)	-4.00 (0.0)	4.4	3.0	9.0[1]
King Salmon Airport	3.72 (0.8)	1.50 (0.7)	-0.28 (2.4)	-1.89 (2.0)	-3.06 (1.5)	-3.50 (1.0)	5.5	3.8	5.2
Silver Salmon Creek	3.20 (1.8)	2.20 (2.2)	0.80 (2.8)	-0.60 (3.1)	-1.80 (3.5)	-2.00 (3.5)	7.7	4.2	5.4
Upper Twin Lakes	3.50 (0.7)	2.50 (0.7)	0.00 (1.4)	-2.50 (2.1)	-3.00 (1.4)	-3.50 (0.7)	6.0	3.0	0.0[2]

Note. Superscripts represent statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Fish Caught per Day with Previous Scarring (KATM only)

The number of fish caught per day with previous scarring was only tested at KATM. Like groups encountered per day, this indicator was only provided to respondents selecting angling as the primary activity during their trip. Acceptability of fish caught per day with previous scarring did not differ statistically across locations at any condition. However, respondents intercepted at Crosswinds Lake reported slightly higher acceptability than those intercepted at the King Salmon Airport for all conditions except 0 scarred fish, where respondents intercepted at the King Salmon Airport report slightly higher levels of acceptability (Crosswinds Lake: M = 3.48; King Salmon Airport: M = 3.61). The threshold was highest at Crosswinds Lake (6.2) and lowest at the King Salmon Airport (5.1). The expected and experienced conditions did not differ statistically across groups but were slightly higher among those intercepted at Crosswinds Lake.

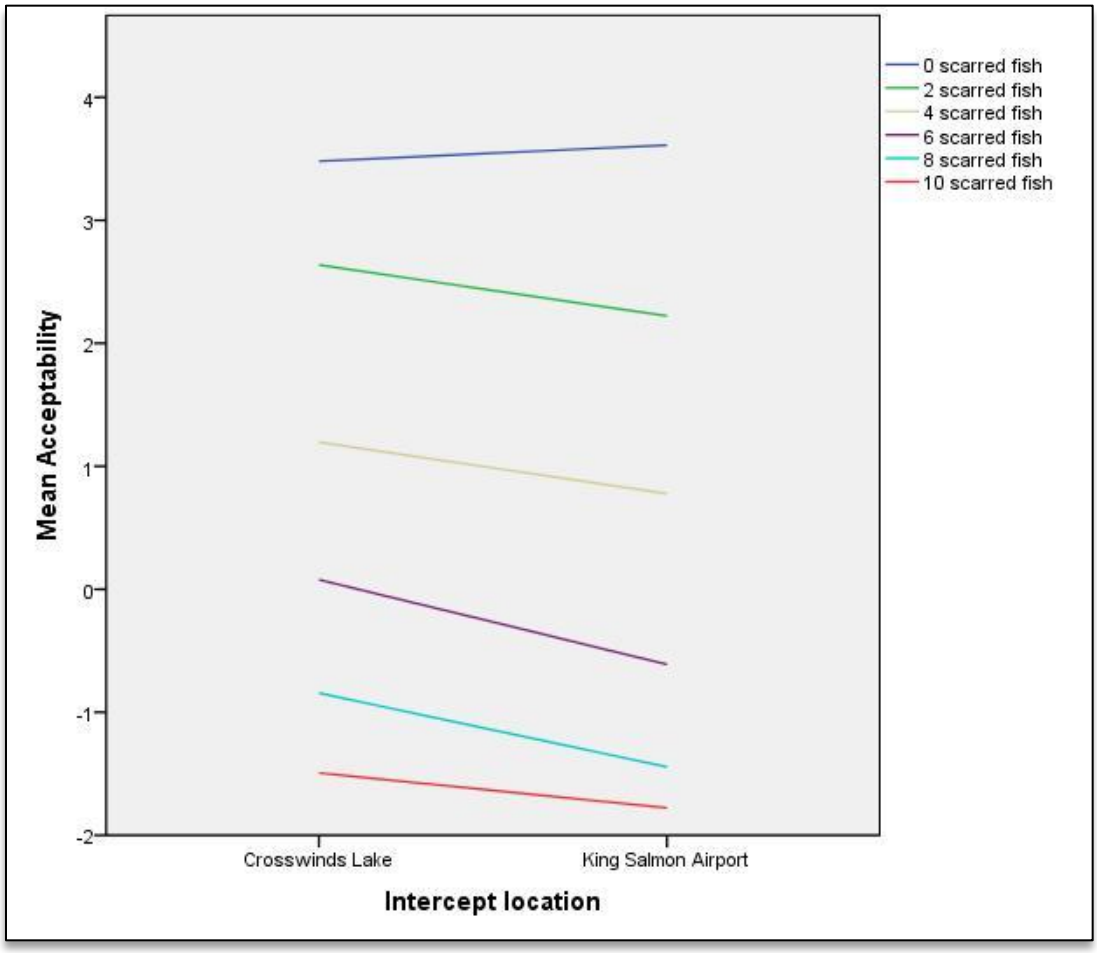


Figure 54. Mean level of acceptability for each presented condition in regard to fish caught per day with previous scarring.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 31. *Mean (SD) level of acceptability for fish caught per day with previous scarring, by intercept location.*

	0 scarred fish	2 scarred fish	4 scarred fish	6 scarred fish	8 scarred fish	10 scarred fish	Threshold (fish)	Average Expected (fish)	Average Experienced (fish)
Crosswinds Lake	3.48 (1.6)	2.64 (1.7)	1.19 (2.3)	0.08 (2.4)	-0.84 (2.5)	-0.40 (3.6)	6.2	2.0	2.0
King Salmon Airport	3.61 (1.0)	2.22 (2.0)	0.78 (2.0)	-0.61 (2.4)	-1.44 (2.7)	-1.78 (2.7)	5.1	1.9	1.7

Note. There were no statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Vegetation Degradation surrounding Angling Sites (LACL only)

The amount of vegetation degradation surrounding angling sites was only tested at LACL. Like groups encountered per day, this indicator was only provided to respondents selecting angling as the primary activity during their trip. Acceptability of vegetation degradation seen did not differ statistically across locations at any condition. However, as conditions worsened, variation between sites increased. At 25% degraded, respondents intercepted at Upper Twin Lakes reported higher levels of acceptability (M = 2.50) than did those intercepted at Crescent Lake (M = 1.81) or Silver Salmon Creek (M = 1.40). At 50% and 70% degraded, respondents intercepted at Crescent Lake reported higher levels of acceptability than did those intercepted at Silver Salmon Creek and Upper Twin Lakes. The threshold was highest at Crescent Lake (53.8%) and lowest at Silver Salmon Creek (36.0%). The expected and experienced conditions did not differ statistically across groups but were highest among those intercepted at Silver Salmon Creek, who reported the lowest level of acceptability for both 24% and 40% degraded.

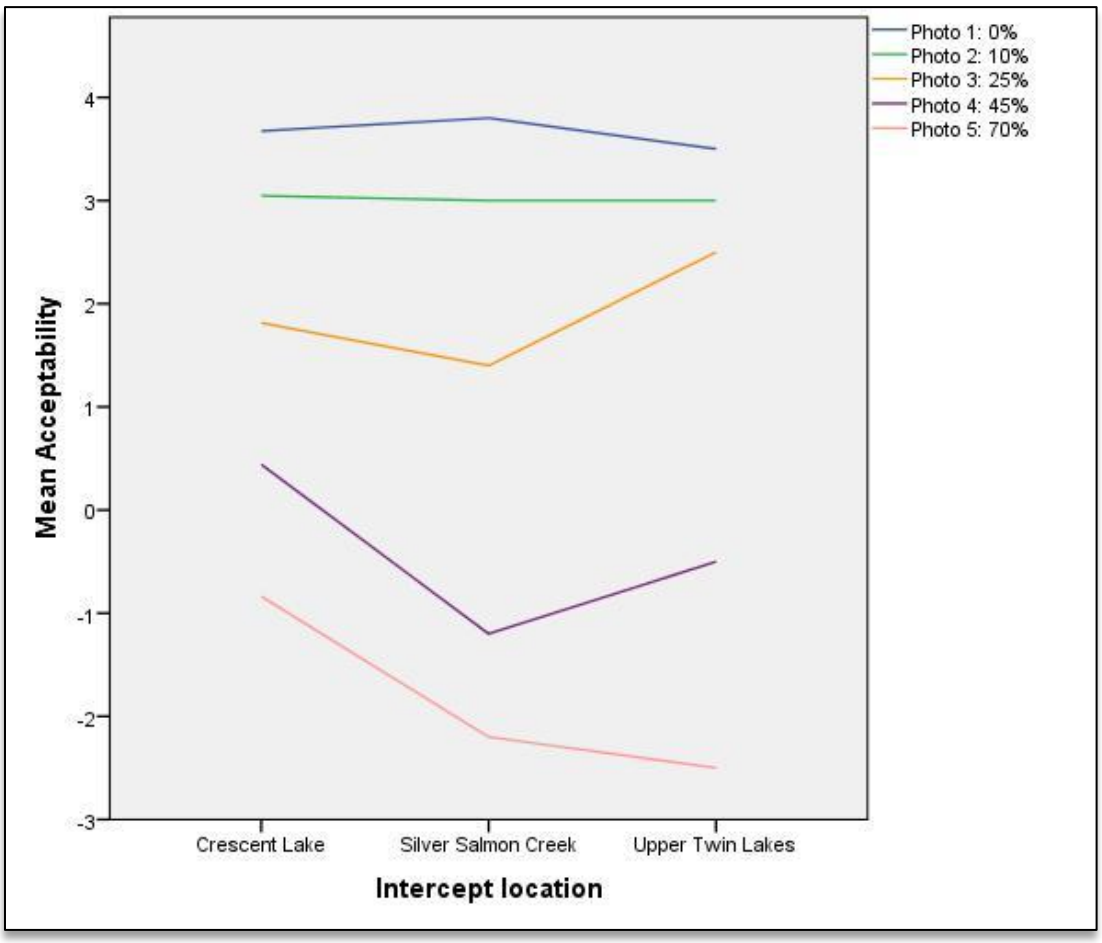


Figure 55. Mean level of acceptability for each presented condition in regard to the amount of vegetation degradation surrounding popular angling sites.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 32. *Mean (SD) level of acceptability for vegetation degradation surrounding angling sites, by intercept location.*

	Photo 1 (0%)	Photo 2 (10%)	Photo 3 (25%)	Photo 4 (45%)	Photo 5 (70%)	Threshold (% degraded)	Average Expected (% degraded)	Average Experienced (% degraded)
Crescent Lake	3.67 (0.9)	3.05 (1.0)	1.81 (2.1)	0.44 (2.5)	-0.84 (2.7)	53.8	8.8	9.3
Silver Salmon Creek	3.80 (0.4)	3.00 (0.7)	1.40 (2.3)	-1.20 (3.3)	-2.20 (3.0)	36.0	19.0	13.0
Upper Twin Lakes	3.50 (0.7)	3.00 (0.0)	2.50 (0.7)	-0.50 (2.1)	-2.50 (0.7)	42.2	10.0	0.0

Note. There were no statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Groups within View at One Time (GAOT)

As mentioned previously, this indicator was only presented to respondents NOT selecting angling as the primary activity during their trip. This was mainly bear viewing but included other activities such as backcountry hiking, hunting, flightseeing, and photography as well. Acceptability was high (M = 3.84) and did not differ statistically across locations for 0 groups within view. For 2 groups, acceptability was statistically higher for respondents intercepted at Silver Salmon Creek (M = 3.84) than those intercepted at Chinitna Bay (M = 2.80). For 6 groups, acceptability was statistically higher for respondents intercepted at Upper Twin Lakes (M = 2.43) than those intercepted at Crosswinds Lake (M = -1.35) and Hallo Bay (M = -0.95). As conditions worsen, respondents intercepted at Crosswinds Lake, Hallo Bay, and the King Salmon Airport reported lower levels of acceptability while those intercepted at Upper Twin Lakes were the only ones to report an average acceptability greater than zero for 8 groups (M = 1.71) and 10 groups (M = 0.71). The threshold was highest at Upper Twin Lakes (11.1), with the next highest at Port Alsworth and Silver Salmon Creeks (5.7) and the lowest at Crescent Lake (4.0). The average expected conditions did not differ statistically across groups, but the average experienced condition was statistically higher for Crosswinds Lake (M = 3.4) and the King Salmon Airport (M = 3.0) than for Port Alsworth (M = 1.4).

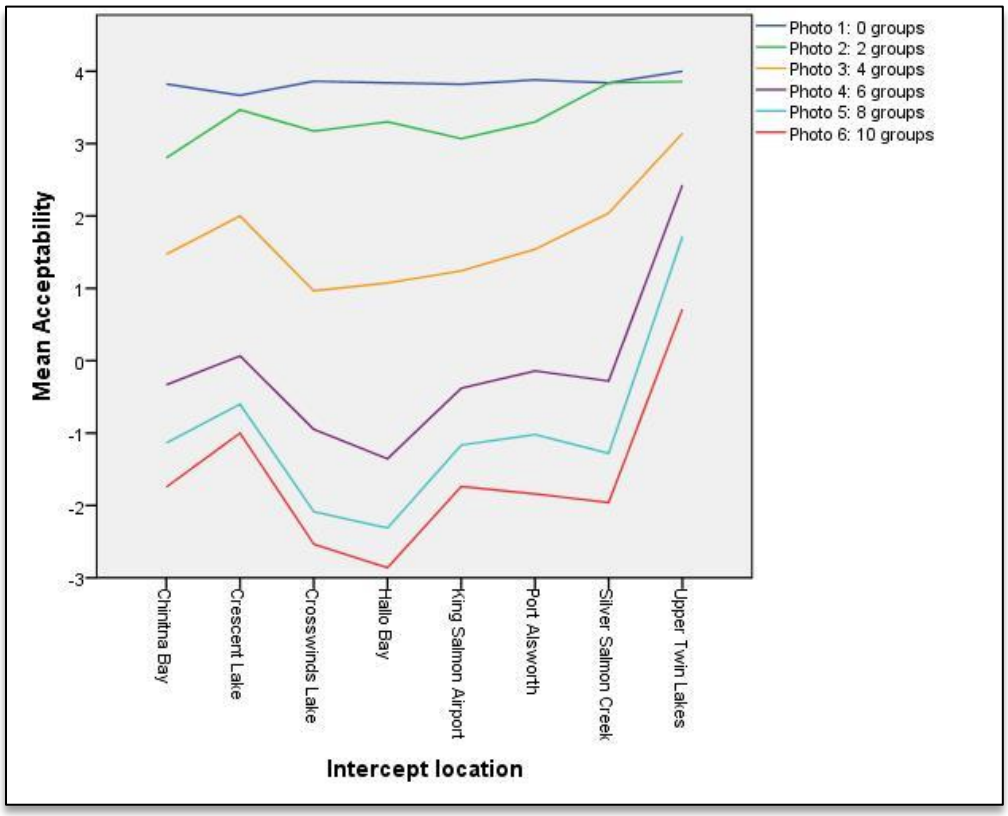


Figure 56. Mean level of acceptability for each presented condition in regard to groups within view at one time.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 33. *Mean (SD) level of acceptability for groups within view at one time, by intercept location.*

	Photo 1 (0 groups)	Photo 2 (2 groups)	Photo 3 (4 groups)	Photo 4 (6 groups)	Photo 5 (8 groups)	Photo 6 (10 groups)	Threshold (groups)	Average Expected (groups)	Average Experienced (groups)
Chinitna Bay	3.82 (0.6)	2.80 (1.8)[2]	1.47 (2.3)	-0.33 (2.7)	-1.14 (2.7)	-1.75 (2.7)	5.6	2.3	2.7
Crescent Lake	3.67 (1.0)	3.47 (1.2)	2.00 (2.3)	0.07 (2.6)	-0.60 (2.7)	-1.00 (2.7)	4	3.1	2.5
Crosswinds Lake	3.86 (0.4)	3.17 (1.2)	0.97 (2.2)	-0.95 (2.5)[2]	-2.09 (2.4)[2,3]	-2.53 (2.2)[2,3]	4.9	2.3	3.4[1]
Hallo Bay	3.84 (0.9)	3.30 (1.1)	1.08 (2.4)	-1.35 (2.3)[2]	-2.31 (2.0)[3]	-2.86 (1.7)[3]	4.8	2.5	2.5
King Salmon Airport	3.82 (1.0)	3.07 (1.4)	1.24 (2.4)	-0.38 (2.6)	-1.17 (2.5)[2]	-1.74 (2.4)[1,2]	5.4	2.6	3.0[1]
Port Alsworth	3.88 (0.3)	3.30 (1.1)	1.54 (2.0)	-0.14 (2.5)	-1.02 (2.3)	-1.84 (2.3)	5.7	2.1	1.4[2]
Silver Salmon Creek	3.84 (0.8)	3.84 (0.6)[1]	2.04 (1.9)	-0.28 (2.5)	-1.28 (2.3)	-1.96 (2.4)	5.7	3.0	3.1
Upper Twin Lakes	4.00 (0.0)	3.86 (0.4)	3.14 (0.7)	2.43 (1.1)[1]	1.71 (1.1)[1]	0.71 (1.6)[1]	11.1	2.3	1.4

Note. Superscripts represent statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Bears Viewed per Hour

Like GAOT, this indicator was only presented to respondents NOT selecting angling as the primary activity during their trip. This was mainly bear viewing but included other activities such as backcountry hiking, hunting, flightseeing, and photography as well. Acceptability was statistically higher for 0-1 bears at the King Salmon Airport (M = 2.04) and Port Alsworth (M = 1.53) than at Crosswinds Lake (M = -0.11) and Hallo Bay (M = -0.20). For 2-3 bears, acceptability was rated statistically higher by those intercepted at the King Salmon Airport (M = 2.35) and Port Alsworth (M = 1.92) than those intercepted at Hallo Bay (M = 1.22). At 4-5 bears per hour or greater, acceptability begins to decrease among respondents intercepted at the King Salmon Airport and Port Alsworth, with reported acceptability levels for 10-11 bears of 0.80 and 0.59, respectively. These are the only ratings for this condition below 2.5. Beginning at 4-5 bears per hour, acceptability becomes statistically higher at Chinitna Bay, Crosswinds Lake, Hallo Bay, and Silver Salmon Creek than at the King Salmon Airport and Port Alsworth.

A limited sample size from Upper Twin Lakes (n = 7) limits the possibility of interpretation, but the acceptability rating for 0-1 bears per hour at this site (M = -0.86) was well below the ratings for all other conditions at this site and the only rating across all sites and conditions below -0.2.

Important to note, in addition to the trends seen among respondents from the King Salmon Airport and Port Alsworth, the average acceptability decreases slightly between 8-9 bears (M = 3.22) and 10-11 bears (M = 3.09) for Chinitna Bay, Crosswinds Lake, and Silver Salmon Creek. The threshold was highest for Chinitna Bay at 12.75 bears per hour. This unusually high threshold is due to the slight decrease in acceptability between 8-9 and 10-11 bears, and its impact on the trend line. The trend line for all other locations crossed the x-axis (threshold) at least once between zero and ten, but for Chinitna Bay the only other intercept point would require seeing less than zero bears per hour. The next highest threshold was Crosswinds Lake (1.1) with the lowest threshold at the King Salmon Airport (0.02).

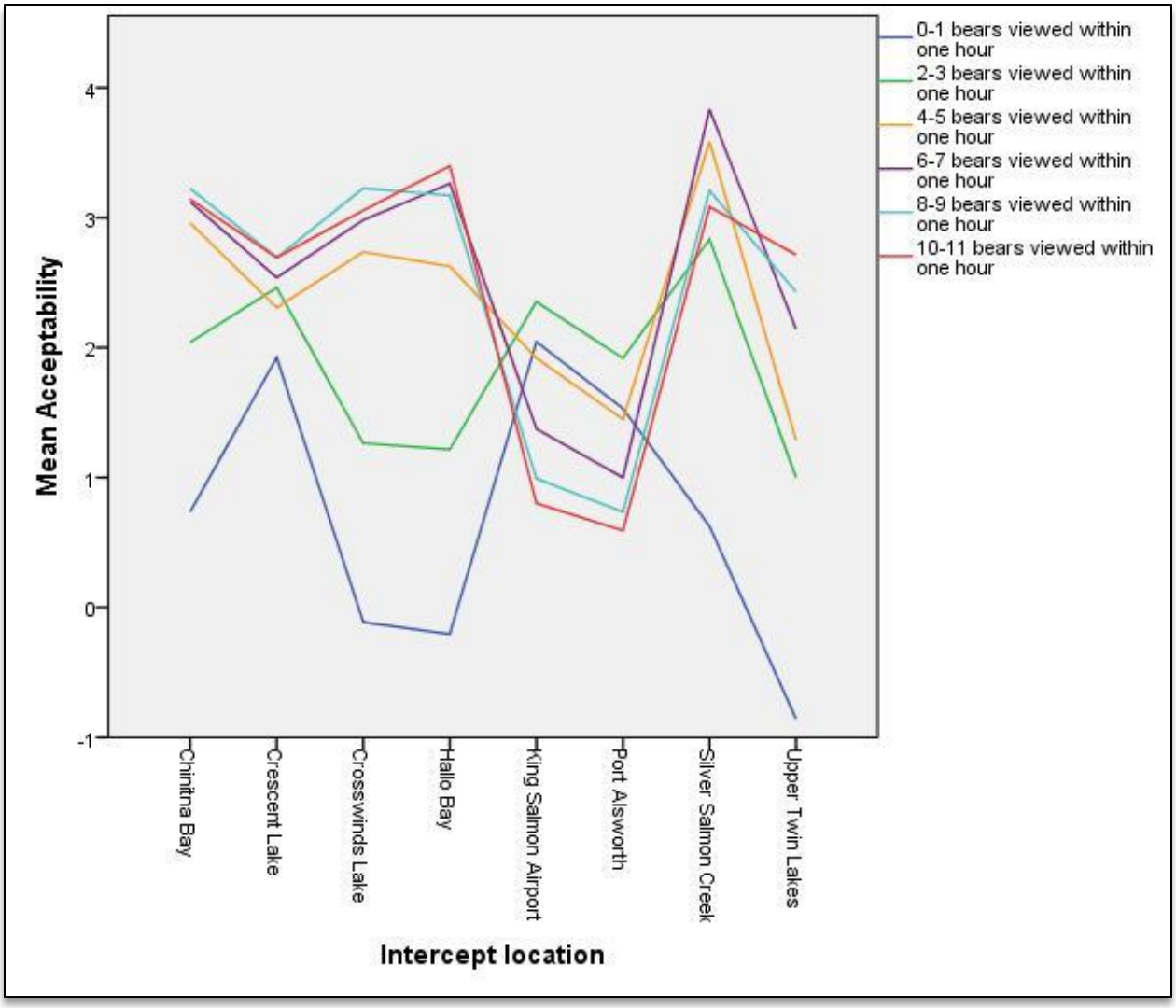


Figure 57. Mean level of acceptability for each presented condition in regard to bears viewed per hour.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 34. *Mean (SD) level of acceptability for bears viewed per hour, by intercept location.*

	0-1 bears	2-3 bears	4-5 bears	6-7 bears	8-9 bears	10-11 bears	Threshold (bears)	Average Expected (bears)	Average Experienced (bears)
Chinitna Bay	0.73 (2.7)	2.04 (1.9)	2.96 (1.6)[1]	3.12 (1.6)[1]	3.22 (1.5)[1]	3.14 (1.8)[1]	12.75	3.9[1,2]	3.9[2,3]
Crescent Lake	1.92 (1.8)	2.46 (1.8)	2.31 (1.8)	2.54 (2.0)	2.69 (2.1)	2.69 (2.1)	0.2	2.3	2.0[2,3,4]
Crosswinds Lake	-0.11 (2.3)[2]	1.26 (2.2)	2.74 (1.3)[1,2]	2.98 (1.5)[1]	3.23 (1.4)[1]	3.06 (1.7)[1]	1.1	3.6[1,2]	4.5[1,2]
Hallo Bay	-0.20 (2.6)[2]	1.22 (2.4)[2]	2.63 (1.7)[1,2]	3.26 (1.2)[1]	3.17 (1.7)[1]	3.40 (1.6)[1]	0.9	3.9[1]	5.9[1]
King Salmon Airport	2.04 (2.2)[1]	2.35 (2.0)[1]	1.92 (2.3)[2,3]	1.38 (2.7)[2]	0.99 (3.0)[2]	0.80 (3.2)[2]	0.02	2.7[2,3]	2.5[3,4]
Port Alsworth	1.53 (2.7)[1]	1.92 (2.1)	1.45 (2.3)[3]	1.00 (2.4.)[2]	0.73 (2.7)[2]	0.59 (3.1)[2]	0.2	1.7[3]	1.5[4]
Silver Salmon Creek	0.63 (2.6)	2.83 (1.7)[1]	3.58 (1.0)[1]	3.83 (0.8)[1]	3.21 (2.1)[1]	3.08 (2.3)[1]	0.4	3.2	1.6[4]
Upper Twin Lakes	-0.86 (3.0)	1.00 (1.6)	1.29 (1.7)	2.1 (2.0)	2.43 (2.5)	2.71 (2.6)	0.5	4.2	3.4

Note. Superscripts represent statistically significant differences ($p < 0.05$) in acceptability ratings or conditions across intercept locations.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

ADDITIONAL ANALYSES

Linear Regression • **Anglers vs. Bear Viewers** • **Crowding Density** • **Utilization Distributions**

Additional Analyses

Linear Regression Analysis

Since the pattern in acceptability regarding distance to a bear and number of bears viewed differed substantially across intercept location, the research team decided to investigate potential explanations. This was done using a univariate general linear model through IBM's SPSS. A general linear model is a form of linear regression that uses a list of independent, or explanatory, variables to estimate one (univariate) or more (multivariate) dependent variables (Montgomery, Peck, & Vinning, 2012). This analysis was performed twice, each with one dependent variable, the linear threshold for that indicator. The linear thresholds were calculated for each individual using a linear best fit line. The research team used Microsoft Excel to determine the equation of this line, from which the x-intercept (i.e. the threshold) can be calculated. A linear trend line was used as opposed to the fifth-order polynomial trend line to avoid immense computational complexity. In order to perform this analysis, several assumptions must be addressed (Montgomery, Peck, & Vinning, 2012). These include:

1) Relationship must be linear
2) Residuals must be normally distributed
3) Independent variables must not be highly correlated (explain the same variation)
4) Residuals (difference from each point to the estimate) must be independent of each other
5) Residuals must be equal across the regression line

While relationships present were not decidedly linear, the trends can still be approximated using a linear model. The residuals are approximately normally distributed. Five explanatory (i.e. independent) variables were used: average experienced distance to a bear, closest experienced distance to a bear, number of bears experienced per hour, main activity during visit, and distance photo provided. Closest and average distances were understandably highly correlated but conceptually explain different elements of the experience, so were both still included. The number of bears viewed per hour was moderately correlated with both distance measures, but not significantly enough to warrant concern. Lastly, considering the highly variable nature of social science data, the residuals appear relatively independent and consistent across the regression line.

Each linear model produces a test statistic (F-value) and the *p*-value for the entire model. The *p*-value can be interpreted in the same manner as described in previous sections of this report. It is the probability of achieving a test statistic as or more extreme, assuming there is no relationship between the variables. A value of less than 0.05 is considered statistically significant. The model also produces an F-value and *p*-value for each independent variable, interaction term, and an intercept for the line. An interaction term is a relationship between two or more variables in which the level of one variable impacts the effect of another variable. For example, the age of an individual might impact their response to a new drug. In addition, the entire model is given an R^2 value. This value represents the amount of variation in the data that is explained by the given model. For example, an R^2 of 0.4 indicates that 40% of the variation seen is explained by the model. Inclusion of many independent variables will increase the overall R^2 value but may not

provide any additional explanation of the variation. The adjusted R^2 value takes this into account and ignores all repetitive explanations of variation. Potentially relevant independent variables were added and taken out of the models, and the model with the highest adjusted R^2 value was chosen. All analyses in this section incorporates responses from both parks to increase the power to detect relationships.

Predicting the Threshold for Distance to a Bear

Table 35. *Results of univariate general linear model predicting the linear threshold regarding distance to a bear. *p < 0.05.*

	df	F-value	*p* value	R^2	Adjusted R^2
Corrected Model	31	3.842	< 0.001*	0.240	0.178
Intercept	1	11.08	0.001*		
Average Distance	5	3.99	0.002*		
Bears Viewed	6	5.03	< 0.001*		
Distance*Bears	20	4.79	< 0.001*		

Results

The general linear model with the highest adjusted R^2 value for distance to a bear included only two independent variables. These were the average experienced distance to a bear and the average experienced number of bears viewed per hour. Conceptually, these variables may not cause the thresholds but may be useful predictors. Individuals may previously possess a conceptual threshold, impacting their choice of activity and locations to visit based on expected conditions. The conditions experienced, then, are not developing an individual's threshold but instead, predicting their previously derived threshold. Results of this model demonstrate a statistically significant effect of both independent variables, as well as the interaction term on the linear threshold. Given the highly variable nature of the data, the relatively small, adjusted R^2 of 0.178 suggests the model explains a fair amount of the variation. These three effects, as well as that of main activity type, were plotted to better understand these relationships.

Interpretation

In regards to the average experienced distance to a bear, those who viewed bears at an average of 10, 25, or 75 yards showed higher acceptability at closer distances and lower acceptability at further distances than those who viewed bears at an average of 50 or 100 yards or saw no bears at all. These trends meet at approximately 50 yards, with all experienced conditions reporting high levels of acceptability. For the number of bears viewed per hour, all but one condition reported almost identical trends in acceptability. Respondents who viewed an average of 8-9 bears per hour reported significantly lower acceptability for 10 yards and higher acceptability for 100 yards than all other conditions. Again, 50 yards received high acceptability ratings across all experienced conditions. For the interaction between average distance and number of bears, the researchers plotted the ideal distance to a bear against the average number of bears viewed for each experienced distance. The ideal distance to a bear was determined by averaging the

acceptability of each condition (0 to 100 yards) for every combination of average distance experienced and number of bears viewed. The condition with the highest average acceptability in each class was determined to be the ideal distance. When two or more conditions received the same average acceptability rating, conditions were averaged. For example, if 25 yards and 50 yards each received the same, highest rating, the ideal condition was listed as 37.5 yards. Linear trend lines were added for each average experienced distance. For those who saw bears at an average of 10 or 50 yards away, as the number of bears viewed per hour increases, the ideal distance decreases. In other words, those who visit locations with many bears at close distances, prefer to view bears at closer distances than those who visit locations with fewer bears. For respondents who saw bears at an average of 25 or 100 yards away, an increase in the number of bears viewed per hour does not impact the ideal distance. Among individuals who reported an average distance of 75 yards, an increase in the number of bears viewed per hour results in an increased ideal distance. Lastly, while not statistically significant, acceptability differed across activity types. For anglers and backcountry users, acceptability increases as distance to a bear increases, while the opposite is true for bear viewers and photographers. However, a distance of approximately 25 yards produced a high level of acceptability across all four main activity types.

Predicting Accuracy of Distance Estimates

Table 36. *Results of univariate general linear model predicting the accuracy of distance estimates.*

	df	F-value	*p* value	R^2	Adjusted R^2
Corrected Model	110	3.18	<0.001*	0.447	0.306
Intercept	1	32.84	<0.001*		
Photo Shown	4	7.05	<0.001*		
Main Activity	3	6.50	<0.001*		
Closest Distance	5	0.12	0.988		
Average Distance	5	1.44	0.208		
Activity*Closest	5	3.72	0.005*		
Activity*Average	4	7.35	<0.001*		

*$p < 0.05$.

Each respondent to the questionnaire was asked to rate the acceptability of viewing a bear at five distances (10, 25, 50, 75, and 100 yards) using computer-manipulated photos. After answering these questions, respondents were randomly presented with one of the five photos and asked to estimate the distance to the bear. The researchers converted all responses to yards in order to assess accuracy. Understanding accuracy can help park management and CUA operators in keeping safe distances from bears. A univariate general linear model was developed to predict the accuracy of respondents. Accuracy was calculated for each respondent by subtracting their response from the actual distance in the photo. For example, when considering the photo at 25 yards, a guess of 20 yards would produce an accuracy score of -5, while a guess of 30 would produce an accuracy score of 5.

General linear models were tested using demographic as well as experience characteristics, but demographics had little impact on the predictive ability of the model. The general linear model with the highest adjusted R^2 value accuracy included four independent variables and a host of significant interaction terms. Independent variables included the photo provided, activity type, closest experienced distance to a bear, and average experienced distance to a bear. Results of this model demonstrate a statistically significant effect of the photo shown and the activity type. The photo shown impacts the effect of activity type as well as closest and average experienced distances. The activity type also impacts the effect of the closest and average experienced distances. An adjusted R^2 value of 0.306 suggests this model explains a good amount of the variation present in the data.

As to be expected, the photo provided to the respondent is a statistically significant predictor of their accuracy. In general, accuracy decreased, and the range of values increased with further depicted distances. In terms of activity type, accuracy was fairly similar across activities although photographers were less accurate on average (M = 147.2, SD = 290.6), with more variation than bear viewers (M = 117.2, SD = 186.5), anglers (M = 110.4, 185.4), and backcountry campers and hikers (M = 110.1, 254.6). For the interaction between activity type and photo shown, trends in accuracy were similar among bear viewers and anglers, but

backcountry users and photographers were much less accurate when presented the photo depicting 100 yards. The interactions for photo shown and closest experienced distance and photo shown and average experienced distance were very similar. Trends in accuracy were similar among all experienced distances except for 100 yards. Those who viewed bears at 100 yards, both closest and average, were significantly less accurate in their estimations, particularly at 50 and 100 yards. For the interactions between activity type and closest experienced distance and activity type and average experienced distance, the largest effect exists among backcountry users who saw bears at an average of 100 yards. Estimates for this group were almost 1,000 yards greater, on average, than the depicted distance, while accuracy for the remaining groups never exceeded 300.

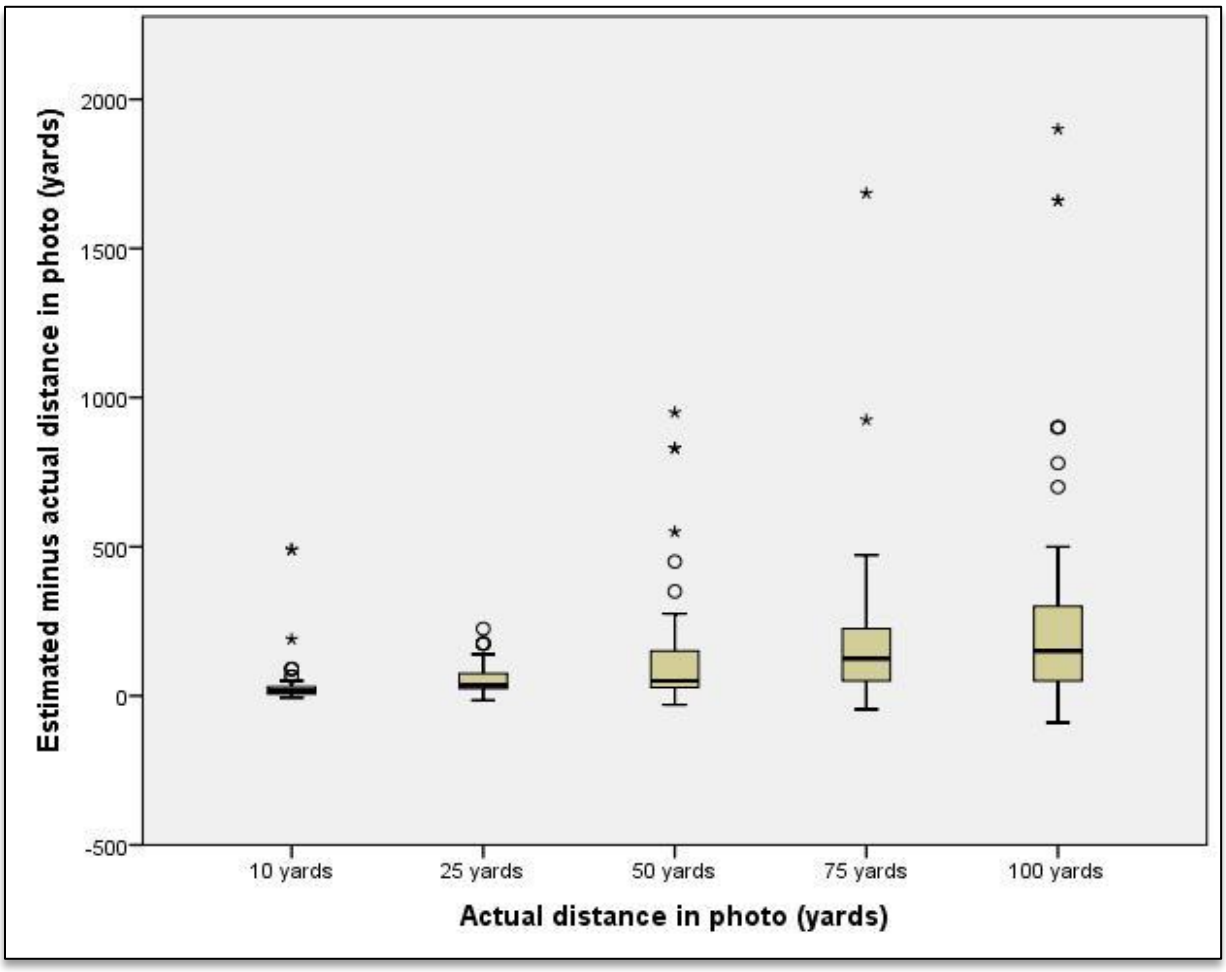


Figure 58. Accuracy scores for distance estimates among respondents when presented with photos depicting various distances to a bear.

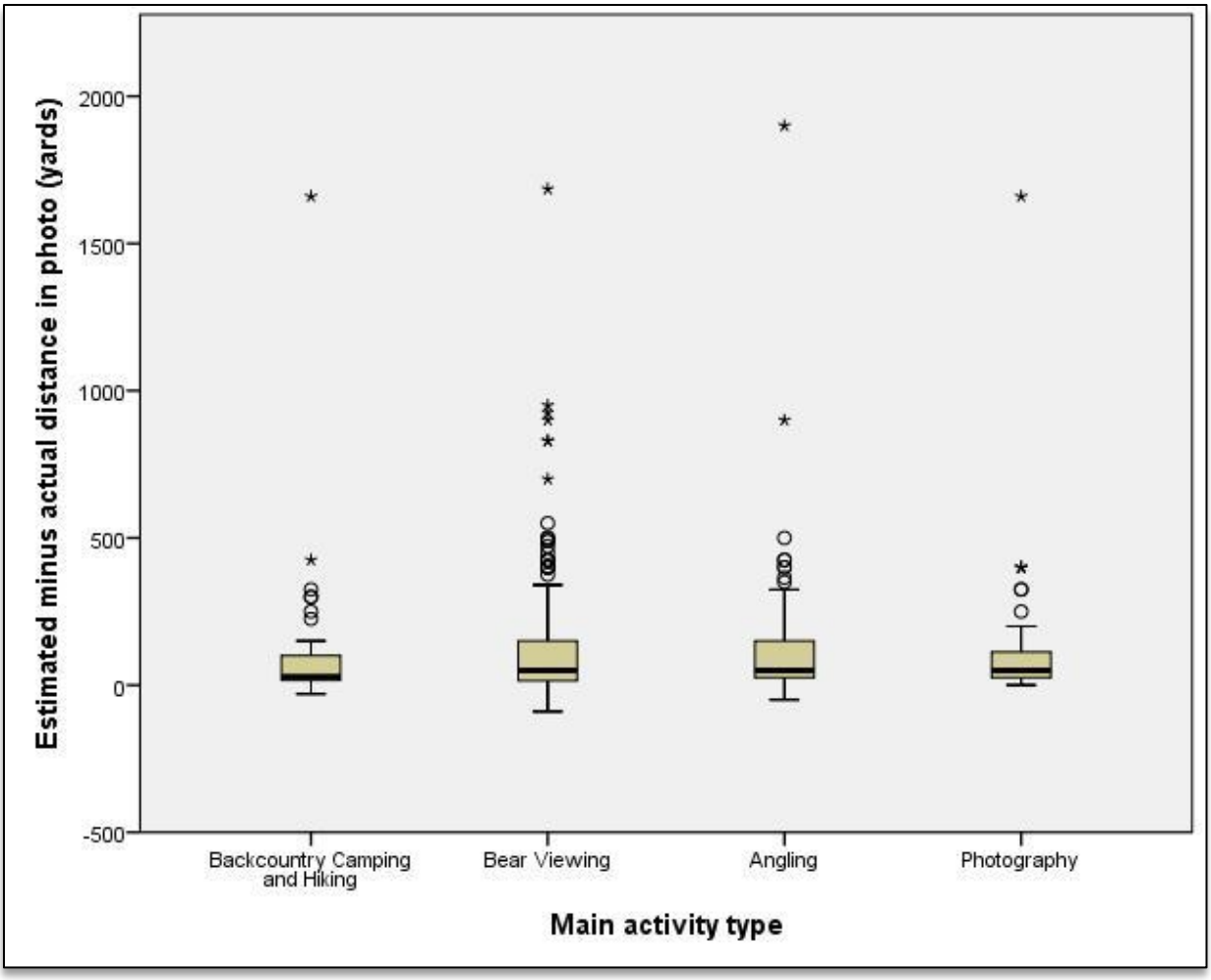


Figure 59. Accuracy scores for distance estimates among respondents of various activity types.

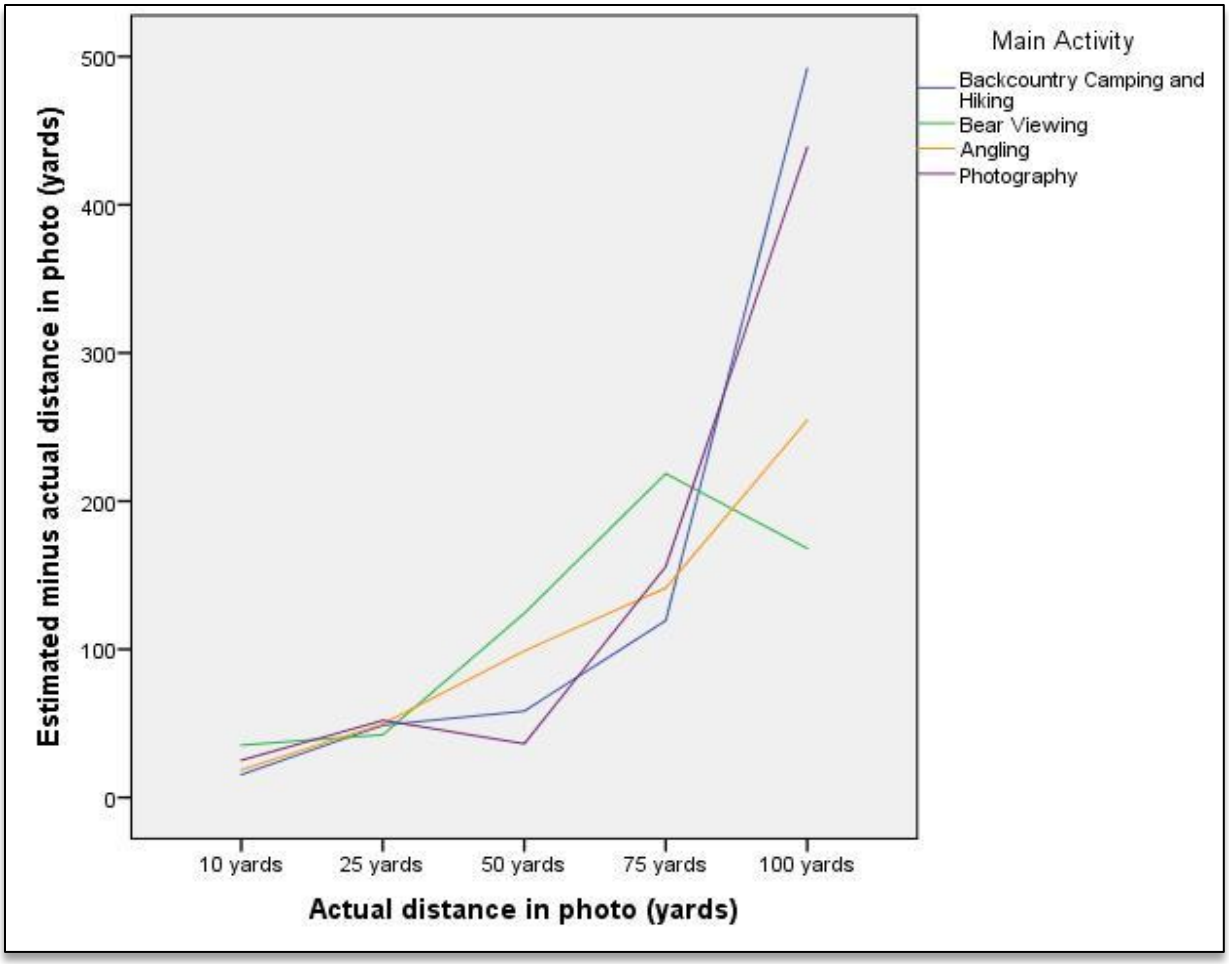


Figure 60. Accuracy scores for distance estimates among respondents when presented with photos depicting various distances to a bear. Separate lines represent different activity types.

Predicting Thresholds from Experienced Conditions

As mentioned previously, it is unknown if experienced conditions impact one's reported thresholds. Thresholds may be formulated from the conditions that an individual experiences during their visit, but they may also be a factor of an individual's previous experiences, attachment to the place, or elements of their personality; all of which are formed prior to the visit. To better understand this phenomenon, the researchers used simple linear regressions to predict linear thresholds from experienced conditions.

Table 37. *Results of linear regressions predicting thresholds from experienced conditions. *p < 0.05*

	β	Std. Error	df	R^2	F-value	*p*-value
Distance to bear	3.73	5.44	581	0.001	0.470	0.493
Anthropogenic sound	-4.68×10^{14}	2.39×10^{15}	547	0.000	0.038	0.845
Groups per day	0.14	1.76	147	0.000	0.006	0.936
Scarred fish caught	0.42	0.79	89	0.003	0.286	0.594
Groups within view	1.95	0.35	437	0.066	30.920	<0.001*
Bears viewed per hour	0.75	0.66	337	0.004	1.291	0.257

Note. For distance to a bear, the average experienced distance was used instead of the closest experienced distance.

Unlike in the previous analyses, the simple regression is performed with one independent variable. The results of six different linear regressions are shown, each with an R^2, F-value, and a *p*-value. The Beta coefficient (β) is a measure of the intensity and direction of the relationship between the independent and dependent variables, essentially the slope of the line. The standard error is a measure of the variation around that slope. For example, with every increase in one group within view, the linear threshold increases by 1.95 (95% CI = 1.25 – 2.65) groups. The massive coefficient for anthropogenic sound represents a slope that is essentially undefined (i.e. vertical), meaning there was little variation in experienced condition regardless of linear threshold. Of the six regressions performed, only groups within view was statistically significant. While the experienced number of groups within view is a significant predictor of the related threshold, this model only explains 6.6% of the variation seen ($R^2 = 0.066$). These results support the notion that experienced conditions on their own are not an effective method in predicting the thresholds.

Comparing Anglers and Bear Viewers

Two primary activities conducted throughout KATM and LACL are angling (n = 172) and bear viewing (n = 326). As discussed previously, these make up a large portion of respondents, who likely value different aspects of their experience. To better understand these differences, the researchers performed additional analyses between these activity types across both parks. First, the researchers compared demographics using independent samples t-tests. While race and income distributions did not differ, statistically more anglers than bear viewers ($p < 0.05$) identified as male (86.3% vs. 50.2%). The researchers then compared past use histories and perceived crowding, all of which were statistically significant. Anglers (M = 3.01) tended to spend approximately one more day in the park than did bear viewers (M = 2.18). Of those who only visited for one day, anglers (M = 6.43) again spent approximately one more hour in the park than did bear viewers (M = 5.55). Anglers (M = 6.68 days, 2.97 years) also tended to be more experienced; having visited the park four more times in the last five years and for one and a half more years total than bear viewers (M = 2.50 days, 1.31 years). Lastly, anglers (M = 2.13) reported statistically higher levels of crowding than did bear viewers (M = 1.57), although neither were considered crowded.

Table 38. *Past use history for anglers and bear viewers. *p < 0.05.*

	Activity	**Mean (SD)**	**Min, Max**	***t*-test**
How many **days** did you spend visiting	Angling	3.01 (2.7)	1, 19	t(363.5) = 3.2
	Bear viewing	2.18 (2.8)	1, 45	p = 0.001*
If you visited for only one day, how many **hours**	Angling	6.43 (1.7)	4, 12	t(256.8) = 2.6
	Bear viewing	5.55 (3.7)	1, 24	p = 0.009*
How many **days** in the last **five years**	Angling	6.68 (11.6)	1, 86	t(185.6) = 4.6
	Bear viewing	2.50 (3.3)	1, 30	p < 0.001*
How many total **years** have you visited	Angling	2.97 (3.9)	1, 21	t(195.0) = 5.4
	Bear viewing	1.31 (1.4)	1, 21	p < 0.001*

Table 39. *Perceived level of crowding across activity types on a seven-point Likert scale. *p < 0.05.*

Activity	Not Crowded (1)	(2)	(3)	(4)	(5)	(6)	Extremely Crowded (7)	Mean (SD)	*t*-test
Angling	43.9	21.6	18.7	10.5	4.1	1.2	0	2.13 (1.3)	$t(272.5) = 5.1$
Bear viewing	63.6	23.4	8.4	3.4	0.6	0	0.6	1.57 (0.9)	$p = 0.001$*

To limit burden on the respondent, each individual was only presented with four total indicators. Two of these were specific to activity type (groups encountered and scarred fish for anglers and groups within view and number of bears viewed for bear viewers), and two were presented to all

respondents, regardless of activity type (distance to a bear and anthropogenic sound). As a result, only distance to a bear and anthropogenic sound heard per hour were comparable across activities. For distance to a bear, 10 yards away was statistically more acceptable among bear viewers (M = 1.05) than anglers (M = 0.19). Both report high acceptability at 25 yards, but acceptability becomes statistically higher among anglers than bear viewers as distance increases. The fifth-order polynomial trend line determined two thresholds for each activity. For anglers, distance becomes unacceptable at 9.6 yards and 133 yards. For bear viewers, distance becomes unacceptable at 7.2 yards and 467 yards. PCI_2 values (i.e. level of disagreement) are highest at either end of the spectrum, especially among bear viewers. For evaluative dimensions, bear viewers reported statistically closer distances for both average (M = 22 yards) and closest (M = 14 yards) distances than did anglers (M = 31 yards, M = 22 yards). Regardless of activity type, average experienced distance to a bear was well below the park recommendation of 50 yards. A large majority of anglers and bear viewers both reported none of the listed conditions to be poor enough to warrant management action or displacement, although the majority was significantly smaller among bear viewers. Among anglers, the second and third most frequent responses to both questions were 10 and 100 yards, respectively. Among bear viewers, the second most frequent response was 10 yards for management action (followed by 100 yards) and 100 yards for displacement (followed by 10 yards). In general, respondents preferred bears to be closer than 50 yards but not closer than 10. Further, this suggests that bear viewers understand the unpredictability of wildlife and are okay viewing bears at long distances but much prefer close experiences, while anglers tended to be more accepting of any condition beyond 10 yards, as long as the bear was close enough to maintain the experience of fishing with Alaskan brown bears.

For anthropogenic sound heard per hour, any condition beyond approximately 15 minutes was deemed unacceptable by both user groups. Acceptability did not differ statistically between groups at zero or 15 minutes but was statistically higher for anglers than bear viewers as conditions worsened. The fifth-order polynomial trend line determined a single threshold for each activity; 18.8 minutes for anglers and 16.7 minutes for bear viewers. PCI_2 values are greatest towards the center of the curve for both activities but larger, on average, among anglers, especially as conditions worsen. For evaluative dimensions, none were statistically different. For both groups, respondents expected to hear approximately 12 minutes of anthropogenic sound per hour but heard an average of 13.3 and a maximum of 17 minutes per hour. Management action was reportedly warranted at 30.4 minutes per hour while displacement would occur at 38.4 minutes. In general, experienced conditions slightly exceed expectations, and anglers are less sensitive to large levels of anthropogenic sound per hour than bear viewers.

Table 40. *Reported acceptability of distance to a bear (yards), by main activity type.*

	Activity	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*-test
Photo 1 10 yards	A	8.2	15.3	10.6	10.6	3.5	10.0	14.7	18.2	8.8	0.19 (2.6)	$t(380.4) = -3.3$
	B	9.6	10.6	6.4	8.3	3.2	7.7	5.4	17.0	31.7	1.05 (2.9)	$p = 0.001$*
Photo 2 25 yards	A	0	0.6	3.5	2.9	1.2	9.4	10.0	30.6	41.8	2.76 (1.6)	$t(480) = 0.3$
	B	1.3	3.2	2.2	2.6	1.3	4.8	5.8	37.8	41.0	2.72 (1.9)	$p = 0.796$
Photo 3 50 yards	A	1.2	2.4	1.8	0.6	1.2	3.5	7.1	22.4	60.0	3.09 (1.7)	$t(398.2) = 4.6$
	B	1.9	1.6	3.2	5.1	6.4	8.7	9.9	28.2	34.9	2.29 (2.0)	$p < 0.001$*
Photo 4 75 yards	A	2.9	4.7	0.6	0	3.5	1.8	1.2	16.5	68.8	3.02 (2.1)	$t(427.3) = 8.3$
	B	6.1	6.7	9.6	10.3	7.1	7.7	5.8	15.1	31.7	1.17 (2.7)	$p < 0.001$*
Photo 5 100 yards	A	6.5	3.5	0.6	2.9	1.2	1.2	1.8	10.6	71.8	2.83 (2.4)	$t(428.6) = 8.9$
	B	16.3	12.8	8.3	2.6	7.7	5.8	3.2	11.9	31.4	0.50 (3.2)	$p < 0.001$*

Note. Listed as percent of the sample, with highest percentages across rows highlighted. *$p < 0.05$.
For Activity, A = Angling, B = Bear viewing

Table 41. *Evaluative dimensions for distance to a bear (yards), by main activity type.*

	Activity	I did not see any bears (-,1)	None of these conditions (-,1)	Photo 1 10 yards (1,2)	Photo 2 25 yards (2,3)	Photo 3 50 yards (3,4)	Photo 4 75 yards (4,5)	Photo 5 100 yards (5,6)	Mean (SD)	*t*-test
Expected	A			29.4	52.9	14.7	1.8	1.2	1.92 (0.8)	$t(478) = -0.6$
	B			27.7	54.5	12.9	2.6	2.3	1.97 (0.8)	$p = 0.547$
Average experienced	A	0		37.6	52.4	7.1	1.2	1.8	2.77 (0.8)	$t(396.6) = 2.7$
	B	11.6		34.2	44.5	7.7	0.6	1.3	2.55 (0.9)	$p = 0.007$*
Closest experienced	A	0		80.0	17.6	1.2	0.0	1.2	2.25 (0.6)	$t(478) = 2.1$
	B	11.3		71.0	15.5	0.6	0.6	1.0	2.11 (0.7)	$p = 0.036$*
Management Action	A		73.4	16.6	3.6	2.4	0	4.1	1.51 (1.1)	$t(452.6) = -5.0$
	B		55.9	17.0	5.9	6.2	6.5	8.5	2.16 (1.7)	$p < 0.001$*
Displacement	A		82.8	10.1	0	1.2	0.6	5.3	1.43 (1.2)	$t(467.1) = -5.5$
	B		68.2	4.3	0.3	5.6	6.6	15.1	2.23 (2.0)	$p < 0.001$*

Note. Listed as percent of the sample, with highest percentages across rows highlighted. *$p < 0.05$.
For Activity, A = Angling, B = Bear viewing

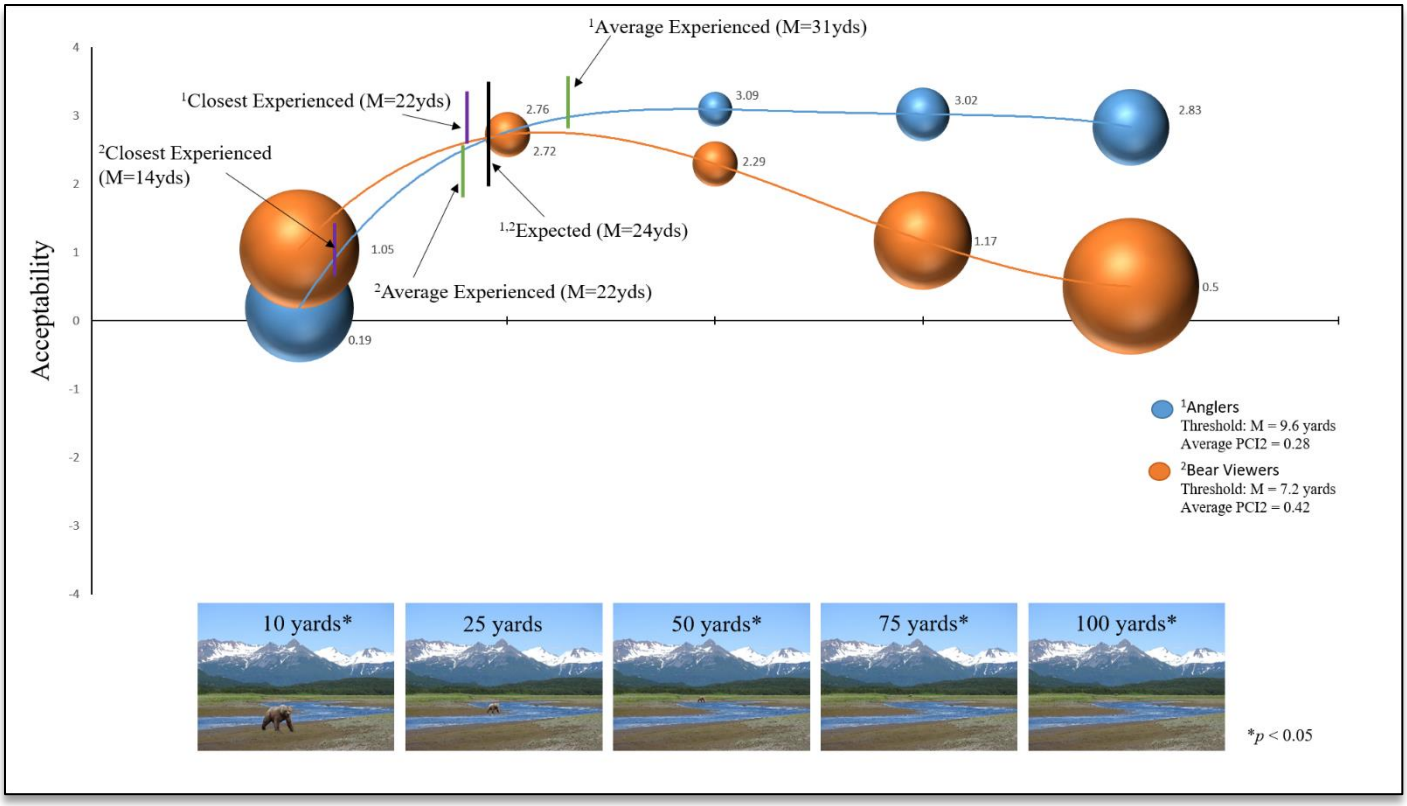


Figure 61. Social norm curve for distance to a bear displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions for anglers and bear viewers. Superscripts represent statistically significant differences in evaluative dimensions between activity groups at the $p = 0.05$ level.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Table 42. *Reported acceptability for anthropogenic sound heard per hour, by main activity type.*

	Activity	Very unacceptable (-4)	Unacceptable (-3)	Moderately unacceptable (-2)	Slightly unacceptable (-1)	Neither (0)	Slightly acceptable (1)	Moderately acceptable (2)	Acceptable (3)	Very acceptable (4)	Mean (SD)	*t*-test
No human sounds	A	2.4	1.8	0.6	2.4	13.8	0.6	3.0	19.8	55.7	2.70 (2.0)	$t(455) = -1.1$
	B	1.7	2.4	2.8	1.4	8.6	1.4	2.1	12.1	67.6	2.91 (2.0)	$p = 0.29$
15 minutes	A	6.0	10.2	10.8	10.8	12.0	10.8	10.2	19.8	9.6	0.42 (2.5)	$t(455) = 0.8$
	B	8.3	12.1	7.9	13.1	9.7	8.3	14.1	20.7	59.0	0.24 (2.5)	$p = 0.454$
30 minutes	A	18.0	20.4	12.6	10.8	11.4	4.2	6.6	11.4	4.8	-0.98 (2.2)	$t(308.9) = 2.3$
	B	22.4	21.7	12.1	14.8	9.7	6.6	5.9	4.8	2.1	-1.53 (2.2)	$p = 0.022$*
45 minutes	A	32.9	22.2	12.0	7.8	7.2	5.4	3.6	4.2	4.8	-1.86 (2.4)	$t(295.1) = 3.1$
	B	43.4	23.4	12.8	5.5	4.8	2.8	3.4	2.1	1.7	-2.52 (2.0)	$p = 0.002$*
60 minutes	A	53.9	14.4	5.4	4.8	9.0	3.0	0.6	3.5	5.2	-2.38 (2.4)	$t(272.8) = 3.3$
	B	65.2	17.9	3.8	2.4	5.2	0.7	1.0	2.1	1.7	-3.09 (1.8)	$p = 0.001$*

Note. Listed as percent of the sample, with highest percentages across rows highlighted. *$p < 0.05$.
For Activity, A = Angling, B = Bear viewing

Table 43. *Evaluative dimensions for anthropogenic sound per hour, by main activity type.*

	Activity	Mean (SD)	Min, Max	*t*-test
Expected	A	11.43 (10.9)	0, 60	$t(452) = -1.1$
	B	12.66 (12.0)	0, 60	$p = 0.279$
Average Experienced	A	12.76 (11.5)	0, 60	$t(452) = -0.9$
	B	13.87 (12.9)	0, 60	$p = 0.360$
Maximum Experienced	A	17.33 (14.1)	0, 60	$t(445) =0.5$
	B	16.66 (15.2)	0, 60	$p = 0.648$
Management Action	A	31.36 (18.6)	0, 60	$t(441) = 1.9$
	B	29.38 (18.0)	0, 60	$p = 0.276$
Displacement	A	38.50 (19.3)	0, 60	$t(441) = 0.1$
	B	38.38 (18.6)	0, 60	$p = 0.946$

Note. Listed as percent of the sample. *$p < 0.05$.
For Activity, A = Angling, B = Bear viewing

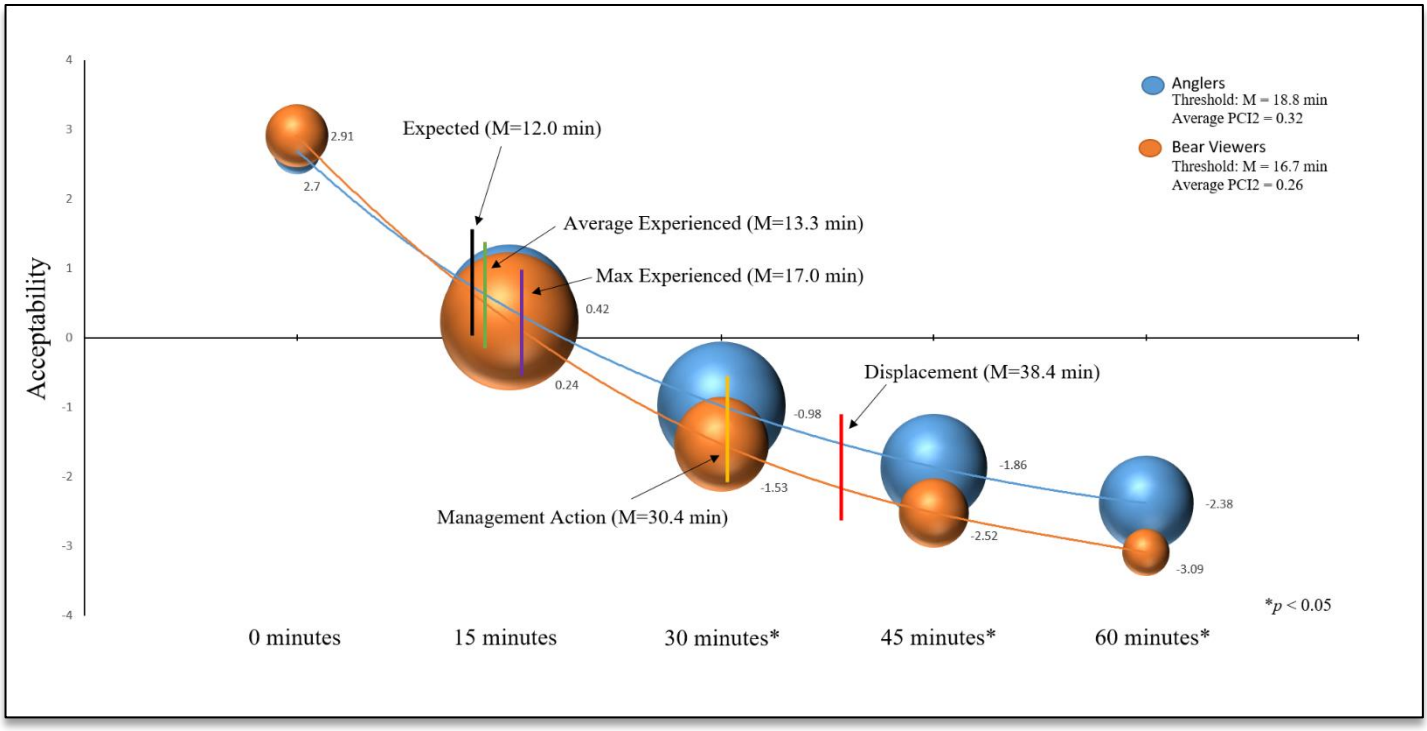


Figure 62. Social norm curve for anthropogenic sound heard per displaying the mean acceptability, PCI_2 values, threshold, and relevant evaluative dimensions for anglers and bear viewers.

For acceptability: -4 = very unacceptable, -3 = unacceptable, -2 = moderately unacceptable, -1 = slightly unacceptable, 0 = neither acceptable not unacceptable, 1 = slightly acceptable, 2 = moderately acceptable, 3 = acceptable, 4 = very acceptable.

Lastly, regarding the impact of an indicator on experience quality, only anthropogenic sound heard per hour had a statistically different impact between groups. Bear viewers (M = 3.34) report the experienced conditions slightly increased the quality of the experience, while anglers (M = 3.14) report statistically less impact. This relationship mirrors the slightly less negative acceptability among anglers compared to bear viewers as anthropogenic sound per hour increases.

Table 44. *Impact of experienced condition on the quality of the experience, by indicator and main activity.*

Indicator	Activity	Extremely decreased (1)	(2)	Neither increased nor decreased (3)	(4)	Extremely Increased (5)	Mean (SD)	*t*-test
Distance to Bear	A	1.8	0	25.4	38.5	34.3	4.04 (0.9)	$t(474) = 0.3$ $p = 0.749$
	B	2.6	5.5	23.5	33.2	37.8	4.01 (1.0)	
Anthropogenic sound	A	1.3	10.7	66.7	15.1	6.3	3.14 (0.7)	$t(400.8) = -2.4$ $p = 0.017$*
	B	2.4	11.1	53.1	16.7	16.7	3.34 (1.0)	

Note. Impact of experienced condition on the quality of the experience, by indicator and main activity. Listed as percent of sample with the highest value across rows highlighted. *$p < 0.05$.
A = anglers, B = bear viewers.

Density Analysis

Visitors to Katmai National Park and Preserve reported a threshold of 5.1 groups while those to Lake Clark National Park and Preserve reported a threshold of 5.9 groups within view. However, these values are difficult to internalize without a more meaningful interpretation of "within view." For this analysis, the research team defined "within view" as an area no larger than 0.25 square miles, with a perimeter no longer than 2 miles. In calculating this value, the research team used similar methods as used to create the distance to bear photo series. The researchers placed an additional group in the background of the 'groups in view' photo series and measured the pixel height. This value, the average human height, and the metadata for the base photo in the photo series were entered into an online calculator (Fulton, 2015; *scantips.com*) to determine the depicted distance between the camera and the farthest group.

Table 44. *Calculating the depicted distance to the farthest group in the edited 'groups within view' photo.*

Variables Crop factor: 5.6; Sensor dimensions: 6.16 x 4.62 mm; Aspect ratio: 4:3; Lens focal length: 4mm; Height size of sensor (image height): 3456 pixels; Height of object in image: 13 pixels; Height of real object: 5.5208 feet (1682.73984mm)
Estimates Scantips using crop factor: 1317.0 feet; Scantips using sensor size height: 1322.0 feet Scantips using sensor size height: 1313.0 feet https://www.scantips.com/lights/subjectdistance.html
Average distance: 1,317.3 feet ~ 0.25 miles

Because the farthest visible group was approximately 0.25 mile from the camera, the research team assumed a viewing distance of 0.25 miles in each of the four primary directions; resulting in a square viewing area with sides of 0.5 miles, an area of 0.25 square miles, and a perimeter of 2 miles. However, not all viewing areas are perfectly square. As a result, the rules were loosened to include any shape with an area no greater than 0.25 square miles and a perimeter no longer than 2 miles. The research team worked with park managers to determine locations of higher use and thus, the highest potential for crowding. Draft analysis areas were drawn using Google Earth, then sent to park staff for revision. After completing the recommended edits, the researchers used the park-specific threshold for groups within view (5.1 groups at KATM; 5.9 groups at LACL) to determine how many groups could be present within the prime bear viewing area at various high use locations without violating the threshold.

For Katmai, every 0.25 square miles could contain no more than 5.1 distinct groups (defined as 3-6 people). The researchers used this density threshold to determine the maximum number of groups within the prime viewing area at each of five high use locations and the size of the resulting buffer around each group. The primary viewing area at Kulik River can host the most groups before the threshold is reached (5.1 groups), while that at Swikshak Lagoon can host the fewest groups (2.0 groups).

For Lake Clark, every 0.25 square miles could contain no more than 5.9 distinct groups (defined as 3-6 people). The researchers used this density threshold to determine the maximum number of groups within the prime viewing area at each of three high use locations and the size of the resulting buffer around each group. The primary viewing area at Silver Salmon Creek can host the most groups before the threshold is reached (5.2 groups), while that at Crescent Lake can host the fewest groups (2.4 groups).

Table 46. *Site-specific density thresholds at prime viewing areas in KATM*

Location	Area (mi^2)	Area (acres)	Maximum Number of Groups	Group Buffer (acres per group)
Geographic Harbor	0.1	42.5	2.0	20.8
Hallo Bay	0.19	121	3.9	31.2
Kulik River	0.25	162	5.1	31.8
Moraine/Funnel	0.21	137	4.3	32.0
Swikshak Lagoon	0.12	74.0	2.4	30.2

GH

HB

KR

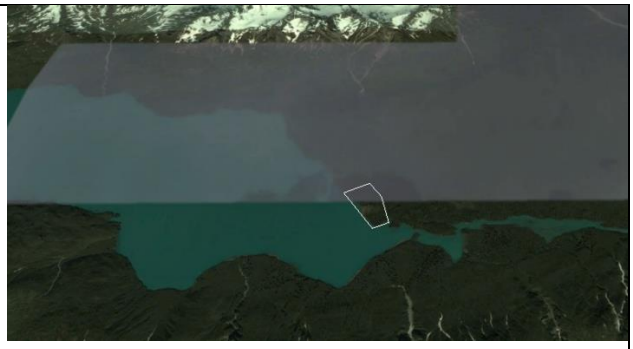
MF

SL

Table 47. *Site-specific density thresholds at prime viewing areas in LACL*

Location	Area (mi^2)	Area (acres)	Maximum Number of Groups	Group Buffer (acres per group)
Chinitna Bay	0.20	139	4.7	27.3
Crescent Lake	0.10	42.3	2.4	17.9
Silver Salmon Creek	0.22	129	5.2	26.8

CB



CL

SSC

Utilization Distributions

Commercial use reports have been previously analyzed by parks to determine trends in visitor use. For example, at Katmai and Lake Clark National Parks and Preserves, the results demonstrated fairly consistent use at most backcountry sites across Katmai but significant increases in use at most sites throughout Lake Clark (NPS 2018 a,b). However, these results do not consider the size of each site or the changes relative to use at other sites. To do so, the research team developed several utilization distributions across seasons, years, and activity type.

The utilization distribution (UD) is a common analytical technique within wildlife research (Topping, Lowe, & Casselle, 2005; Keating & Cherry, 2009; Liu, Yang, Yang, Zhao, & Yu, 2010; Chilvers, Amey, Huckstadt, & Costa, 2011). Rather than display the total use, utilization distributions use the relative intensity of use across a particular area and time. This method creates a three-dimensional polyhedron with a volume of 1, where the height of the polyhedron at each location represents the relative intensity of use (Worton, 1989; Jachowski, Millspaugh, Biggins, Livieri, & Matchett, 2010; Millspaugh et al., 2006).

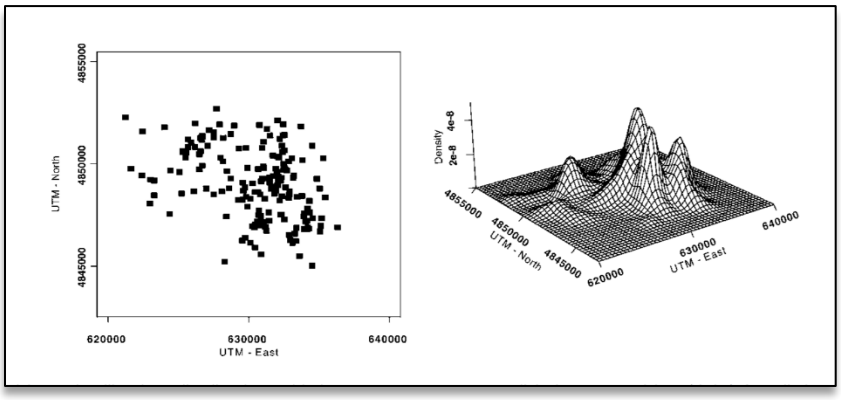


Figure 63. Example utilization distribution (right) for elk locations (left) in Custer State Park, South Dakota. Adapted directly from Millspaugh et al., 2000.

Typically, in wildlife research, utilization distributions are used to define the home range, or primary area of use, of an individual animal (e.g. Topping, Lowe, & Casselle, 2005; Keating & Cherry, 2009). These techniques can assess use at the population level as well (e.g. Liu, Yang, Yang, Zhao, & Yu, 2010; Chilvers, Amey, Huckstadt, & Costa, 2011). Further, a percent of the UD can be used to define a particular type of home range (Powell, 2000; Vila, Beade, & Lamuniere, 2008). A 50%, or core, home range incorporates only 50% of the distribution by including the highest intensities of use until the cumulative volume reaches half of the total volume. Similarly, a 95% home range incorporates the top 95% of use intensity and a 95% chance a member of the study population is present within the UD at any time during the study period.

However, this technique has rarely, if ever, been applied to visitor use in a park or protected area. This novel research provides an example of the benefits of incorporating wildlife and social sciences to better understand visitor use in parks and protected areas.

Selecting locations

In managing for visitor use, both parks have delineated several distinct visitor use monitoring areas, in line with the Southwest Alaska Network (SWAN) monitoring program. Management staff at KATM have traditionally used sixty-one areas while management staff at LACL developed thirty-four areas. Annual CUA reports list the site names for each trip but developing a utilization distribution requires specific locations of use (i.e. GPS points) throughout the study period. To convert site names to specific locations, the researchers used ESRI's ArcMap (version 10.3; Redlands, CA) to outline each of the official visitor use monitoring regions within the park. A sampling grid was placed over these regions with a cell size of one square kilometer then clipped to the park boundaries.

The research team then exported the resulting sampling pool to the open-source statistical software, R (version 3.6.0), and used a stratified GRTS (generalized random tessellation stratified; Stevens & Jensen, 2007) sample to select specific locations, stratified by site. The researchers chose to use a GRTS sample rather than a simple random sample to disperse the generated locations throughout the entire site and avoid any potential clumping of sampled points. This allows for a smoother UD while minimizing the impact of generated data by limiting the analysis to the site level. The researchers used the total number of trips to backcountry locations (excluding Brooks Camp) by any CUA during the study period to determine the number of points to randomly select at each site.

Figure 64. Visitor use monitoring areas at Katmai National Park. Map courtesy of Alaska Region, National Park Service.

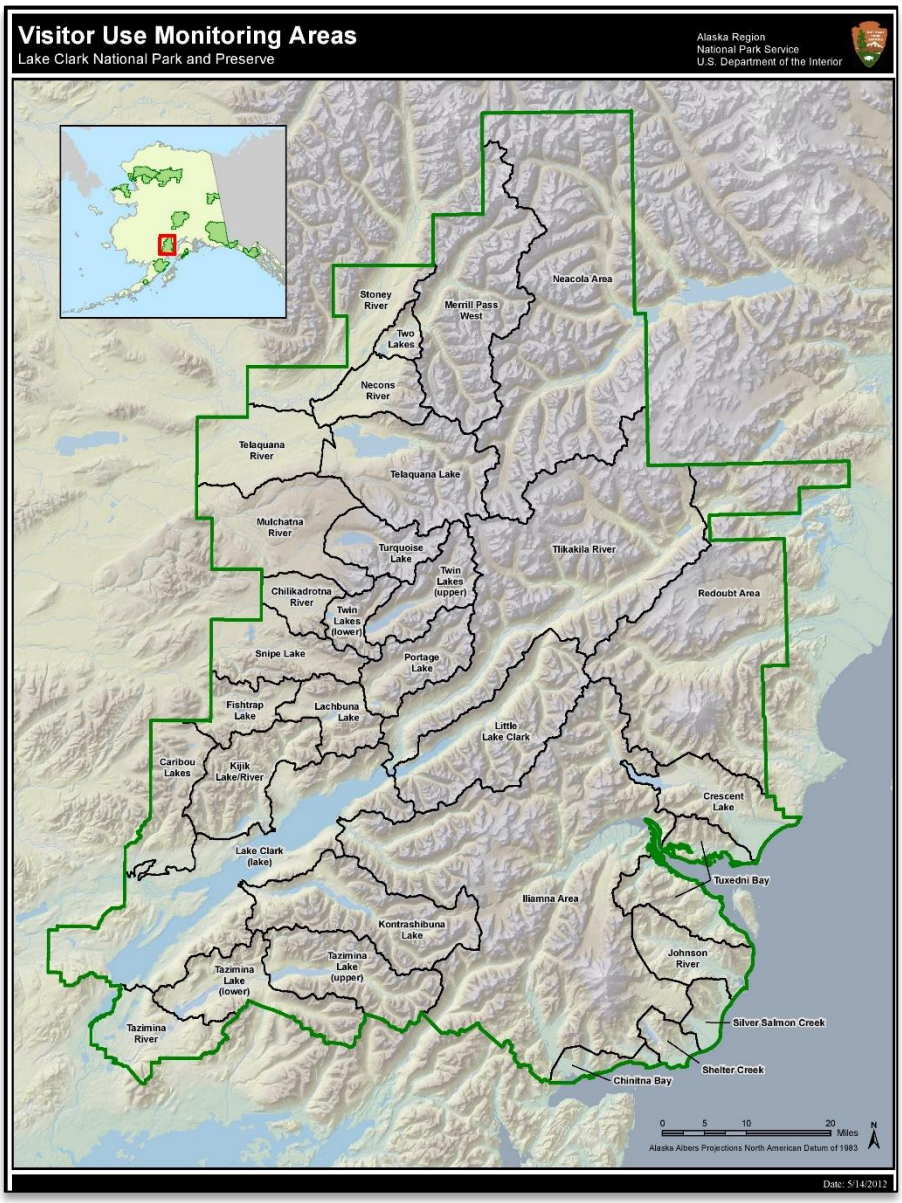


Figure 65. Visitor use monitoring areas at Lake Clark National Park. Map courtesy of Alaska Region, National Park Service.

Analysis

Because use is highly dependent on weather and seasonality, the research team used the three primary visitation months (June, July, and August) to determine the UD sampling period. This resulted in a study period of approximately 90 days each summer for 10 years, from 2008 to 2017. The researchers later subdivided each summer by month to illustrate finer scale trends.

The UD analysis used a plug-in bandwidth selector (Gitzen, Millspaugh, & Kernohan, 2006) and fixed kernel estimates (Blundell, Maier, & Debevec, 2001). The researchers then ran the UD in R and exported results to ESRI's ArcScene (version 10.3; Redlands, CA) to create three dimensional (3D) maps of the distributions. The researchers used a 99% UD in this analysis to account for the maximum number of commercial trips while ignoring areas without use or with only very minimal use. Finally, the results were qualitatively compared across months, years, and activity types within each park to determine trends.

Results

Katmai National Park and Preserve

Use was partitioned using three different variables: season, year, and activity type, to produce a total of 22 different UDs. Prior to displaying the partitioned distributions, each figure displays the overall distribution including all years, seasons, and activities. For each image, the larger the spike within the distribution, the higher the intensity of use. This is also displayed with the transition from green (lowest intensity of use) to red (highest intensity of use). Although the images are three dimensional in ArcScene (10.3), they are necessarily displayed as two dimensional in this report. Two brief videos demonstrating the three-dimensional figures are available at https://tinyurl.com/sv37f28.

Between 2008 and 2017, the relative intensity of use at Kulik River generally decreased while that at the Alagnak River and Lake Camp area generally increased. Across all years, the Moraine Drainage and Funnel Creek Area remained highly popular as have coastal sites such as Hallo Bay and in recent years, Geographic Harbor. Further, while the amount of use has increased from 2008 to 2017, so has the area of use. Sites that had previously seen few trips, like the Valley of Ten Thousand Smokes and Cape Douglas, are beginning to experience higher levels of use.

Visitor use in KATM changes across the summer months as well. Trips to coastal sites, such as Hallo Bay and Geographic Harbor, make up more of the total commercial trips in June and July than they do in August. Further, Kulik River and the Moraine/Funnel area receive an increasingly larger portion of use as the summer continues while trips to the Lake Camp area and Alagnak River remain consistent throughout the summer.

There were six primary activity types listed in CUA reports: air taxi, bear viewing, boating, camping and hiking, photography, and sport fishing. The majority of air taxi trips were to Grosvenor Camp, but Kulik River and the Nonvianuk and Kukaklek Outlets received heavy use as well. For bear viewers, the large majority of trips were to Hallo Bay, followed by Geographic Harbor and the Moraine/Funnel area. Boating trips were primarily to Naknek Lake, Bay of Islands, and the Alagnak River. Over the sampling period, camping and hiking trips occurred throughout the park, but most were to the Valley of Ten Thousand Smokes, with slight use at

Cape Douglas. The primary site for photography trips was Geographic Harbor, followed by Hallo Bay and the Moraine/Funnel area. Lastly, sport fishing trips were almost entirely to Kulik River, with some use at the Lake Camp and Moraine/Funnel areas.

Due to often contrasting motivations, bear viewing and sport fishing have the highest potential for conflict in areas where both occur (for a review of recreation conflict see Manning, 2011). To determine these areas with higher potential for conflict, the researchers plotted the UD for bear viewing and sport fishing on the same map. At KATM, sport fishing and bear viewing typically occur at separate locations. However, both the Moraine/Funnel area and, to a lesser degree, Swikshak, see both user groups; making them areas of potential management concern.

Lake Clark National Park and Preserve

Again, use was partitioned using three different variables, season, year, and activity type, to produce a total of 22 different UDs. The distributions are displayed in the same manner as for Katmai.

Between 2008 and 2017, few shifts occurred in terms of intensity of use. Silver Salmon Creek, Chinitna Bay, Crescent Lake, and Twin Lakes all received fairly consistent use. Further, use does not seem to be expanding beyond these popular areas and the Lake Clark (Port Alsworth) area despite increases in overall use. This would most likely result in increased levels of crowding at all popular locations. Across seasons, intensity of use in the Lake Clark (Port Alsworth) area of the park remained fairly consistent, while the relative intensity increased throughout the summer at coastal sites, including Silver Salmon Creek, Chinitna Bay, and Crescent Lake.

In terms of activity type, air taxi, bear viewing, boating, camping and hiking, photography, and sport fishing were included. The primary sites for air taxi trips were Crescent Lake and the Twin Lakes area, followed by Silver Salmon Creek and Chinitna Bay. Over the sampling period, bear viewing trips only visited Crescent Lake, Silver Salmon Creek, and Chinitna Bay. Boating trips primarily occurred in the Twin Lakes and Lake Clark areas, followed by Crescent Lake. The primary sites for camping and hiking trips were the area around Twin Lakes, including Telaquana Lake, Turquoise Lake, and Kontrashibuna Lake. Photography trips were almost entirely to Silver Salmon Creek, followed by the Twin Lakes area. Lastly, sport fishing trips were primarily to Crescent Lake, followed by the Tazimina River and Silver Salmon Creek.

As with KATM, the researchers plotted the UD for bear viewing and sport fishing at LACL on the same map. This highlights coastal sites, particularly Crescent Lake and Silver Salmon Creek, as areas of potential management concern.

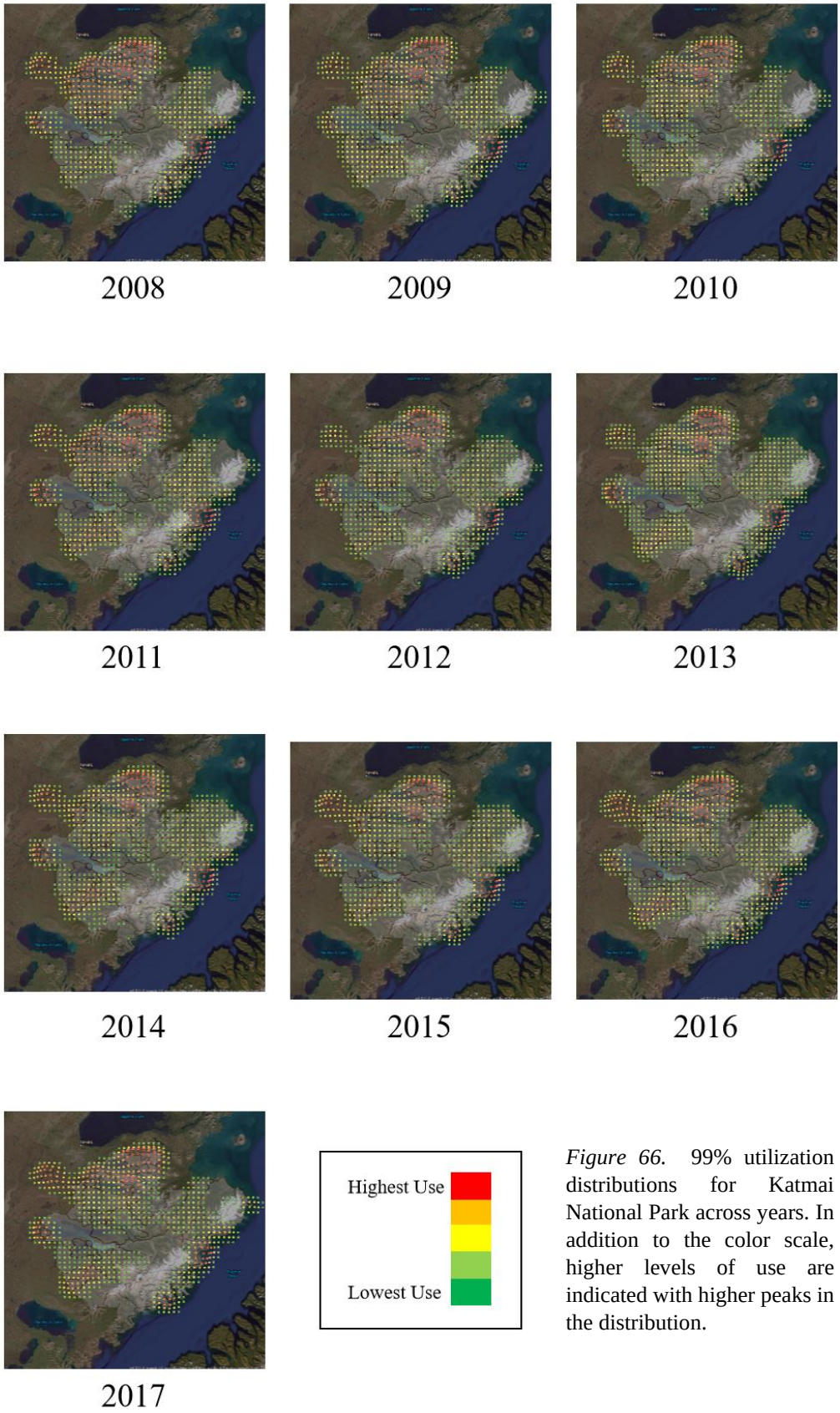


Figure 66. 99% utilization distributions for Katmai National Park across years. In addition to the color scale, higher levels of use are indicated with higher peaks in the distribution.

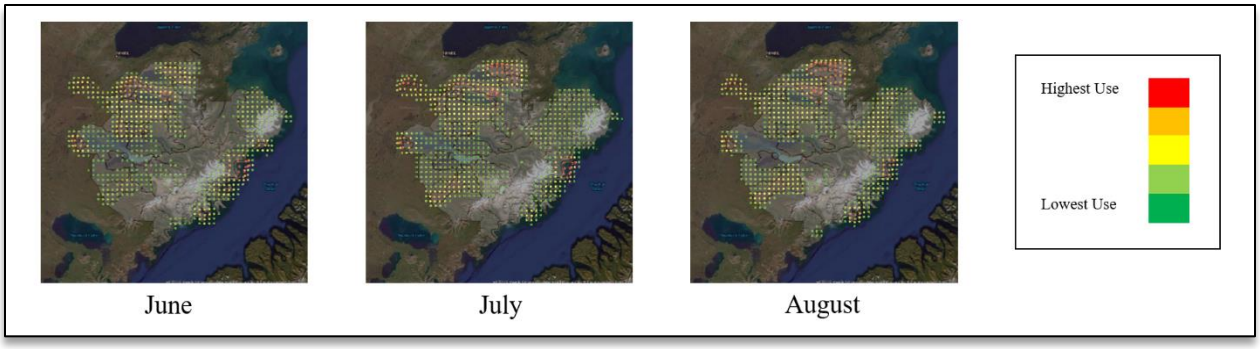


Figure 67. 99% utilization distributions for Katmai National Park across months. In addition to the color scale, higher levels of use are indicated with higher peaks in the distribution.

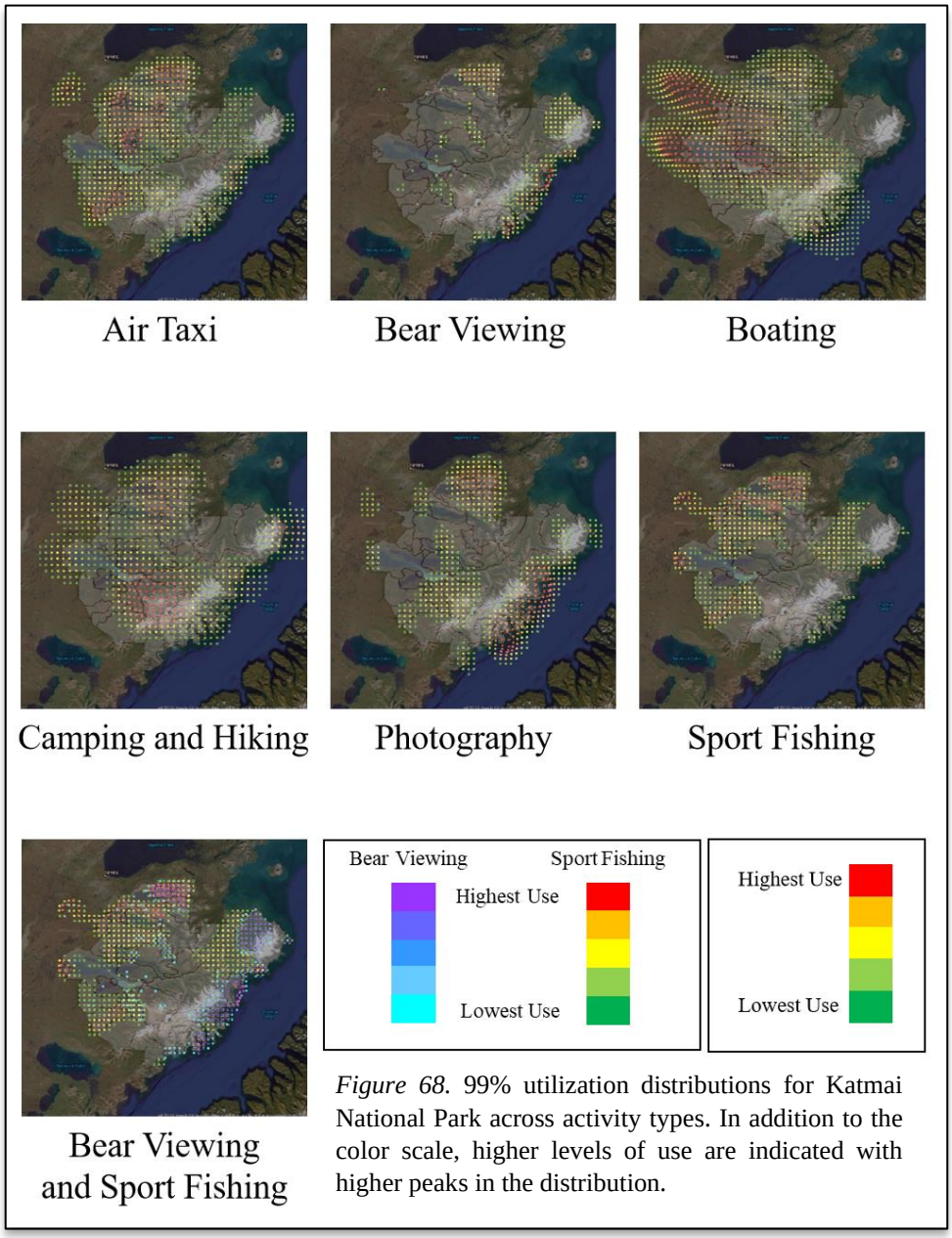


Figure 68. 99% utilization distributions for Katmai National Park across activity types. In addition to the color scale, higher levels of use are indicated with higher peaks in the distribution.

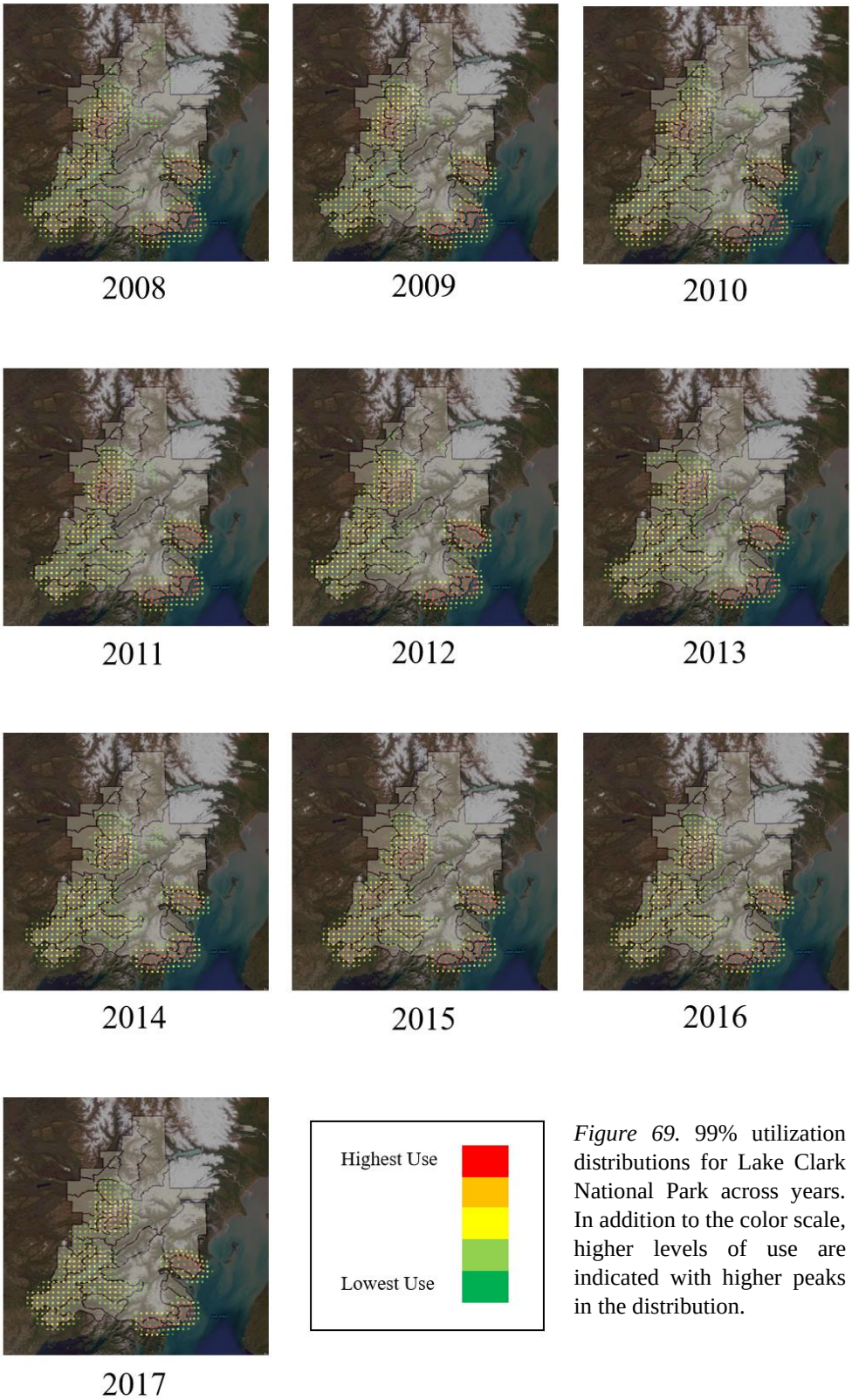


Figure 69. 99% utilization distributions for Lake Clark National Park across years. In addition to the color scale, higher levels of use are indicated with higher peaks in the distribution.

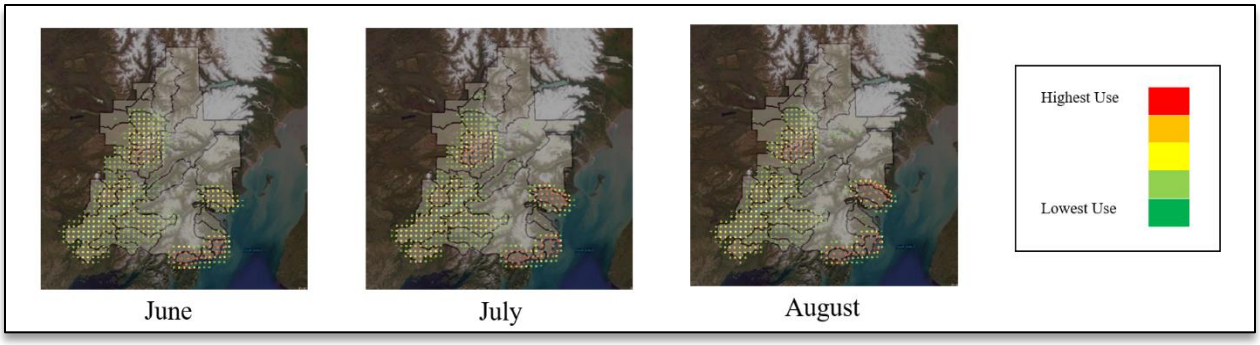


Figure 70. 99% utilization distributions for Lake Clark National Park across months. In addition to the color scale, higher levels of use are indicated with higher peaks in the distribution.

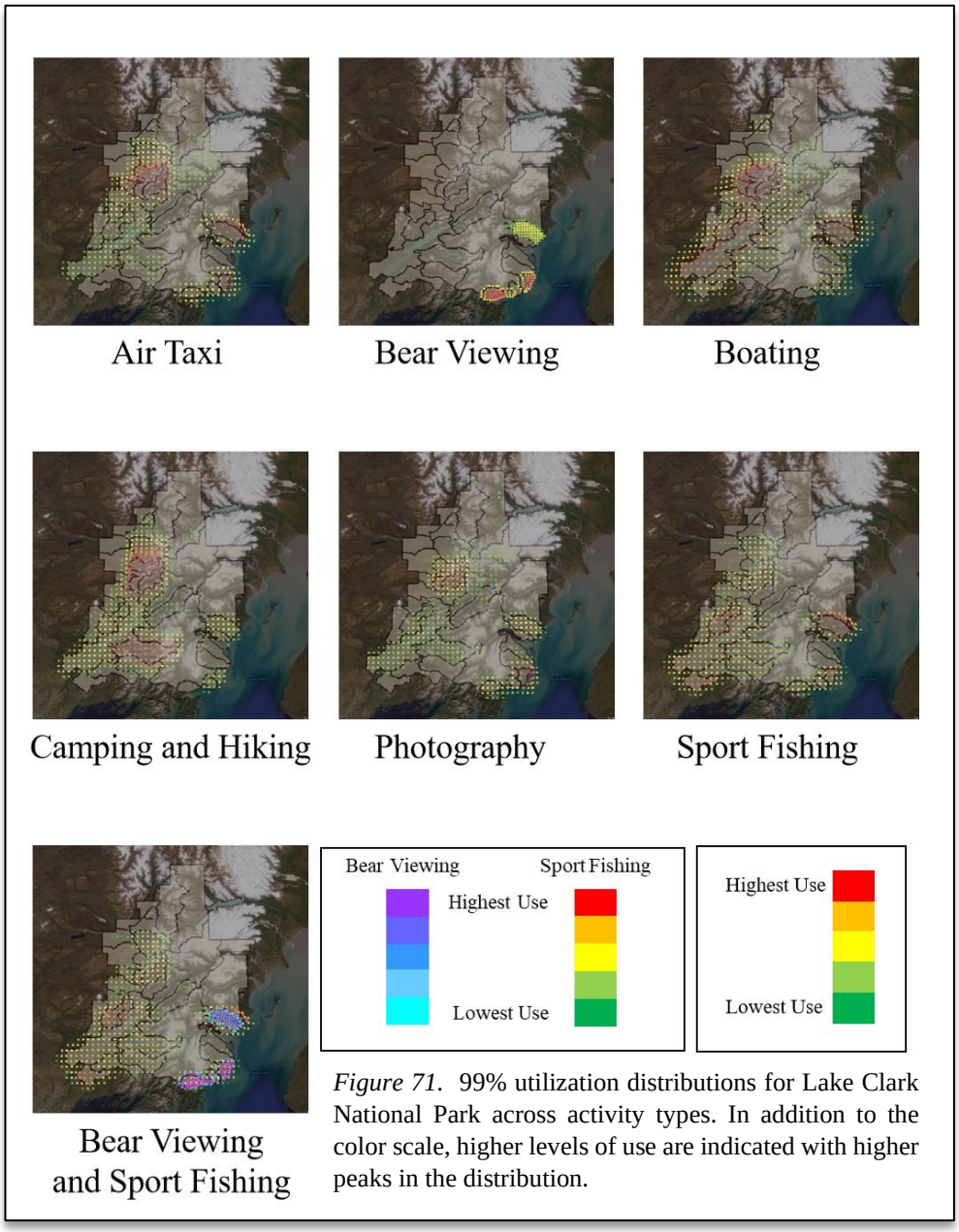


Figure 71. 99% utilization distributions for Lake Clark National Park across activity types. In addition to the color scale, higher levels of use are indicated with higher peaks in the distribution.

Discussion

As opposed to previous frequency data, utilization distributions display the relative intensity of use across the region. Displaying the data in this way allows managers to better understand and visualize trends in visitor use. Specifically, it may help more fully understand visitor patterns at key locations, subsequently informing management actions and strategies, such as the need to manage for solitude or other recreational motivations. For remote parks especially, such as KATM and LACL, this can be a valuable tool within visitor use management. Utilization distributions can help to demonstrate areas with higher potential for user group type conflict (e.g., bear viewing and sport fishing). Further, as opposed to typical visitor use data, UDs can incorporate spatial data to depict changes in the dispersion of visitors throughout the park or highlight sites with high potential for visitor crowding (i.e., intense use in a relatively small area).

These results highlight the potential for wildlife research methods to understand visitor use in large and remote parks. Future research could develop a resource utilization function to predict the intensity of visitor use based on variables such as bear abundance, salmon counts, and vegetative blooms. These could be combined with survey data to address crowding conditions or aspects important to the visitor experience. In addition, for more frontcountry parks, research could potentially use GPS data loggers or similar technologies to develop site-level utilization distributions for group type, travel method, or any number of other relevant variables. This would allow for more specific analysis and eliminate the reliance on previously outlined management areas.

While visitor compliance and the subjectivity inherent in visitor surveys contribute to challenges in incorporating these techniques, the potential for advancement within the field of visitor use management is high. For example, a limitation within this research pertains to the consistent level of uncertainty that remains concerning the accuracy of use data within Alaskan parks (RSG, 2019). This factor could influence produced outcomes (e.g., maps) and result in a developed level of uncertainty from aggregating data during analysis procedures. Therefore, the research team encourages future research, especially within human dimensions, to apply these techniques when applicable and consider all potential influences to produce more reliable and improved data quality. Doing so could not only increase our understanding of visitor use, but also develop the valuable connections between social and wildlife sciences needed in order to achieve positive human-wildlife coexistence.

References

Anderson, L. E., Manning, R. E., Valliere, W. A., & Hallo, J. C. (2010). Normative standards for wildlife viewing in parks and protected areas. *Human Dimensions of Wildlife, 15*(1), 1-15.

Arnberger, A., Eder, R., Allex, B., Sterl, P., & Burns, R. C. (2012). Relationships between national-park affinity and attitudes towards protected area management of visitors to the Gesaeuse National Park, Austria. *Forest Policy and Economics, 19*, 48-55.

Blundell, G. M., Maier, J. A. K., & Debevec, E. M. (2001). Linear home ranges: effects of smoothing, sample size, and autocorrelation on kernel estimates. *Ecological Monographs, 71*(3), 469-489.

Borrie, W. T., Davenport, M., Freimund, W. A., & Manning, R. E. (2002). Assessing the relationship between desired experiences and support for management actions at Yellowstone National Park using multiple methods. *Journal of Park and Recreation Administration, 20*(3), 51.

Bullock, S. D., & Lawson, S. R. (2008). Managing the "commons" on Cadillac Mountain: a stated choice analysis of Acadia National Park visitors' preferences. *Leisure Sciences, 30*(1), 71-86.

Chilvers, B. L., Amey, J. M., Huckstadt, L. A., & Costa, D. P. (2011). Investigating foraging utilization distribution of female New Zealand sea lions, Auckland Islands. *Polar Biology, 34*, 565-574.

Cribbs, T. W., Sharp, R. L., & Brownlee, M. T. (2019). Evaluating the Influence of Photo Order on Park Visitors' Perceptions of Crowding at Buffalo National River. *Leisure Sciences*, 1-19.

Dillman, D. A. (2011). *Mail and Internet surveys: The tailored design method--2007 Update with new Internet, visual, and mixed-mode guide*. Hoboken, NJ: John Wiley & Sons.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. San Diego, CA: Harcourt Brace Jovanovich College Publishers.

Fulton, W. (2015). Calculate Distance or Size of an Object in a photo image. Retrieved from https://www.scantips.com/lights/subjectdistance.html

Gitzen, R. A., Millspaugh, J. J., & Kernohan, B. J. (2006). Bandwidth selection for fixed-kernel analysis of animal utilization distributions. *Journal of Wildlife Management, 70*(5), 1334-1344.

Hallo, J. C., & Manning, R. E. (2009). Understanding and managing the off-road vehicle experience: Standards of quality. *Managing Leisure, 14*(4), 269-285.

Hammitt, W. E., Cole, D. N., & Monz, C. A. (2015). *Wildland recreation: ecology and management*. Chichester, UK: Wiley-Blackwell.

Inglis, G. J., Johnson, V. I., & Ponte, F. (1999). Crowding norms in marine settings: A case study of snorkeling on the Great Barrier Reef. *Environmental Management, 24*(3), 369-381.

Interagency Visitor Use Management Council. (2016). Visitor Use Management Framework: A Guide to Providing Sustainable Outdoor Recreation. Edition One.

Jachowski, D. S., Millspaugh, J. J., Biggins, D. E., Livieri, T. M., & Matchett, M. R. (2010). Home-range size and spatial organization of black-footed ferrets Mustela nigripes in South Dakota, USA. *Wildlife Biology, 16*(1), 66–76.

Keating, K. A., & Cherry, S. (2009). Modeling utilization distributions in space and time. *Ecology, 90*(7), 1971-1980.

Krymkowski, D. H., Manning, R. E., & Valliere, W. A. (2009). Norm crystallization: Measurement and comparative analysis. *Leisure Sciences, 31*(5), 403-416.

Kyle, G., Graefe, A., Manning, R., & Bacon, J. (2004). Effects of place attachment on users' perceptions of social and environmental conditions in a natural setting. *Journal of Environmental Psychology, 24*(2), 213-225.

Laven, D. N., & Krymkowski, D. H. (2005). The relationship between visitor-based standards of quality and existing conditions in parks and outdoor recreation. *Leisure Sciences, 27*(2), 157-173.

Likas, A., Vlassis, N., & Verbeek, J. J. (2003). The global k-means clustering algorithm. *Pattern Recognition, 36*(2), 451-461.

Liu, Q., Yang, J., Yang, X., Zhao, J., & Yu, H. (2010). Foraging habitats and utilization distributions of black-necked cranes wintering at the Napahai Wetland, China. *Journal of Field Ornithology, 81*(1), 21-30.

Loomis, D. K., Anderson, L. E., Hawkins, C., & Paterson, S. K. (2008). Understanding coral reef use: SCUBA diving in the Florida Keys by residents and non-residents during 2006-2007. *HDMCE Analysis Series*, 1-003.

Manning, R.E. (2011). *Studies in Outdoor Recreation*. 3rd edition. Corvallis, OR: Oregon State University Press.

Manning, R. E., & Freimund, W. A. (2004). Use of visual research methods to measure standards of quality for parks and outdoor recreation. *Journal of leisure research, 36*(4), 557-579.

Manning, R., Leung, Y. F., & Budruk, M. (2005). Research to support management of visitor carrying capacity of Boston Harbor Islands. *Northeastern Naturalist, 12*(sp3), 201-220.

Manning, R. E., Valliere, W. A., & Wang, B. (1999). Crowding norms: Alternative measurement approaches. *Leisure sciences*, *21*(2), 97-115.

Marin, L. D., Newman, P., Manning, R., Vaske, J. J., & Stack, D. (2011). Motivation and acceptability norms of human-caused sound in Muir Woods National Monument. *Leisure Sciences*, *33*(2), 147-161.

McLaughlin, W. J., & Paradice, W. E. J. (1980, February). Using visitor preference information to guide dispersed winter recreation management for cross-country skiing and snowmobiling. In *Proceedings of the North American symposium on dispersed winter recreation* (pp. 64-72).

Millspaugh, J. J., Brundige, R. A., & Raedeke, K. J. (2000). Elk and hunter space-use sharing in South Dakota. *Journal of Wildlife Management*, 64(4), 994-1003.

Millspaugh, J. J., Nielson, R. M., Mcdonald, L., Marzluff, J. M., Gitzen, R. A., Rittenhouse, C. D., … Sheriff, S. L. (2006). Analysis of Resource Selection Using Utilization Distributions. *Journal of Wildlife Management*, *70*(2), 384–395.

Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). *Introduction to linear regression analysis* (Vol. 821). Hoboken, NJ: John Wiley & Sons.

Monz, C. A., Cole, D. N., Leung, Y. F., & Marion, J. L. (2010). Sustaining visitor use in protected areas: future opportunities in recreation ecology research based on the USA experience. *Environmental management*, *45*(3), 551-562.

National Park Service. (2018a). Visitor Use, Katmai National Park and Preserve. Retrieved from https://www.nps.gov/articles/visitor-use-katm.htm

National Park Service. (2018b). Visitor Use, Lake Clark National Park and Preserve. Retrieved from https://www.nps.gov/articles/2018-visitor-use-lacl.htm?utm_source=article&utm_medium=website&utm_campaign=experience_more

National Park Service. (2019a). Katmai National Park and Preserve; Welcome to Katmai Country. Retrieved from https://www.nps.gov/katm/index.htm

National Park Service. (2019b). Lake Clark National Park and Preserve; Stunning Wilderness. Retrieved from https://www.nps.gov/lacl/index.htm

National Park Service. (2020). About Us. Retrieved from https://www.nps.gov/aboutus/index.htm

Newman, P., Marion, J. L., & Cahill, K. (2001, January). Integrating resource, social, and managerial indicators of quality into carrying capacity decision-making. In *the George Wright Forum* (Vol. 18, No. 3, pp. 28-40). George Wright Society.

Powell, R. A. (2000). Animal home ranges and territories and home range estimators. In L.

Boitani & T. K. Fuller (Eds.), *Research techniques in animal ecology* (pp. 65–110). New York, NY: Columbia University Press.

Resource Systems Group (RSG). (2019). Alaska region parklands: Quantifying visitation and use. Report submitted to the National Park Service.

Shin, W. S., & Jackson, R. (1997). Wilderness quality and visitors' wilderness attitudes: Management implications. *Environmental Management, 21*(2), 225-232.

Stevens, D. L., & Jensen, S. F. (2007). Sample design, execution, and analysis for wetland assessment. *Wetlands*, *27*(3), 515–523

Tabachnik, B. G., & Fidell, L. S. (2001). *Using multivariate analysis*. 4th Edition. London, UK: Pearson Education.

Topping, D. T., Lowe, C. G., & Caselle, J. E. (2005). Home range and habitat utilization of adult California sheephead, *Semicossyphus pulcher* (Labridae), in a temperate no-take marine reserve. *Marine Biology, 147*, 301-311.

U.S. Census Bureau (USCB). (2020). ACS demographic and housing estimates. Retrieved from https://data.census.gov/cedsci/table?q=demographics&hidePreview=false&tid=ACSDP1Y2018.DP05&vintage=2018.

Vaske, J. J. (2008). Survey research and analysis: Applications in parks, recreation, and human dimensions. State College, PA: Venture.

Vaske, J. J., Beaman, J., Barreto, H., & Shelby, L. B. (2010). An extension and further validation of the potential for conflict index. *Leisure Sciences*, *32*(3), 240-254.

Vila, A. R., Beade, M. S., & Lamuniere, D. B. (2008). Home range and habitat selection of pampas deer. *Journal of Zoology, 276*, 95-102.

Wagstaff, K., Cardie, C., Rogers, S., & Schrödl, S. (2001, June). Constrained k-means clustering with background knowledge. In *Icml* (Vol. 1, pp. 577-584).

Worton, B. J. (1989). Kernel Methods for Estimating the Utilization Distribution in Home-Range Studies. *Ecology*, *70*(1), 164–168.

Appendix A: KATM NPP Preliminary Research Report 2017-2018

Visitor Use and Associated Indicators at Katmai National Park and Preserve

2017-2018

Preliminary Research Report

Preliminary Project Report Prepared by (listed alphabetically):

Project Directors and Principle Investigators
Matthew T.J. Brownlee, Ph.D.[1]
Ryan L. Sharp, Ph.D.[2]

Project Coordinator
Dani T. Dagan[2]

[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 was provided by Sarah C. Jackson in the Park Management and Conservation Lab at Kansas State University.

Executive Summary

The purpose of this research is to gather information to help support management and planning related to day use and overnight visitors in backcountry and wilderness, but not Brooks Camp visitors, at Katmai National Park and Preserve (KATM). The objectives of this study included: 1) evaluate potential indicators for their importance to backcountry day use and overnight visitors and the degree to which they increase or decrease the quality of visitors' experiences, 2) identify thresholds for indicators of quality, and 3) gather baseline information about visitors' soundscape preferences.

The preliminary results can be used to guide the next phase of research and inform preliminary management decisions. Specifically, this research summary is intended to inform and guide NPS managers in developing indicators of quality for monitoring visitor experiences and providing sustainable and appropriate visitor experiences and visitor uses in the backcountry and wilderness areas of the park. Future research will identify thresholds for important indicators, and the results can help guide visitor use management and planning.

Using quantitative questionnaires, this research summary describes information about the conditions that have the greatest influence over backcountry day use and overnight visitor experiences in KATM. Researchers distributed visitor questionnaires at nine intercept areas both in KATM and in regional travel corridors. In addition to collecting on-site questionnaires, researchers distributed an online version of the questionnaire to visitors intercepted same intercept areas by requesting email addresses and distributing survey access information. Results are presented for data relating to visitor demographics and behaviors, indicators of quality, and soundscape preferences.

The report is organized in the following sections: 1) Introduction and Objectives; 2) Methods; 3) Results related to demographics and behavior; 4) Results related to indicators of quality; 5) Results related to soundscapes; and 6) Future research.

Key Recommendations

- Consider adopting the following indicators for monitoring. These indicators emerged as salient, based on both the degree to which they improved their experience, and the number of respondents who identified each as the most important influence on the quality of their experience. The following indicators were most salient out of eighteen potential conditions or experiences related to the overall visitor experience. Also, consider measuring thresholds for the following (*see IVUMC, 2016*).
    1. Visitors' own proximity to bears
    2. Amount of day that wildlife is present
- Consider adopting indicators and establishing thresholds for conditions related to fishing. The following five indicators were selected most often as the most important condition or experience that might influence the quality of a fishing experience in the park.
    1. Conditions of trails and vegetation surrounding fishing locations
    2. Number of other anglers encountered during a single day of fishing
    3. Number of bear encounters experienced for one day that interfered with angling efforts
    4. Amount of time waiting to access a desirable fishing location due to the presence of other anglers
    5. Proximity of other anglers to survey respondent during active fishing time
- Continue considering soundscapes and natural sounds a priority. While sound-related indicators did not emerge as salient, respondents indicated that they are satisfied with the current soundscape and prefer to preserve it; consider limiting increases in these mechanisms (e.g. aircraft traffic, motorized boats). Additionally, measuring the current soundscape at key use areas, including those specified in this report, can serve as an important baseline, especially considering visitor satisfaction with present conditions.
- Consider informing visitors about the types of sounds that will be encountered in the park through interpretation and outreach prior to their arrival.
- As 35 of respondents indicated that their source for learning about the park prior to their visit was different from those listed on the questionnaire (e.g. online sources other than the official website), consider investigating these sources further.
- Because a large majority of visitors indicated that they spent the majority of time in the park with a professional guide, and because overnight visitors largely resided in lodges within the park, continue working closely and collaboratively with commercial use authorized operators.

Key Findings

Response rates (Page 8)

- Overall. 512 visitors completed a questionnaire, achieving a 5-confidence interval at the 95-confidence level. The response rate for on-site questionnaires was 93. Of the 205 online surveys sent, 149 were completed, yielding a response rate of 73. There was only one refusal to provide an email address.
- Katmai (KATM) only. 355 respondents, who were intercepted in either LACL or KATM, indicated that they visited LACL and are included in the findings of this report. This achieves a 5-confidence interval at the 95-confidence level.

Demographics (Page 10)

- Age. The average reported age of KATM visitors was 52.
- Gender. There were 54 male respondents and 46 female.
- Education. 45 of visitors reported attaining a graduate or professional degree and 29 a four-year college degree.
- Income. Respondents reported a relatively even spread of household income levels.
- Race. Most respondents self-identified as white (88).
- Location of primary residency. Most respondents reside in the United States (81) and locations of residences were relatively evenly spread throughout the country.

Behavior and Activities (Page 8)

- Sources of information. The largest group of visitors selected "other" (35) in response to this question. Nearly half of those respondents specified word of mouth (46). The next largest groups indicated the official park website (17) or a guide service (15).
- Day vs. overnight use. Single-day users represent 31 of the sample, 59 spent between 2-7 days, and 10 of respondents spent more than seven days in the park. The largest group of overnight users resided in private business or cabins in the park (16 Brooks Lodge, 19 other) and 32 of respondents reported camping in the park.
- Guided vs. unguided. 46 of respondents reported spending most of their time with a professional guide.
- Destinations. Hallo Bay, a sampling location, was the commonly reported (17) location visited. 28.1 selected that they did not visit any of the areas listed, 27.5 selected "other," and 18 indicated that they did not know the location names of the places they visited. 68 of respondents indicated that the majority of their bear viewing occurred at Brooks Camp.
- Main activity. The most common *main* reason reported for visiting the park was bear watching (63).

Indicators of Quality (Page 13)
To increase robustness, data for both KATM and LACL were combined to assess indicators. While statistically significant differences exist between data sets, the populations are small, the differences in means are not meaningful, and the same two indicators emerge as salient for each park and both combined (see page 13 and appendix B for more information).

- Salient indicators. The most salient indicators were the visitor's own proximity to bears, and the amount of the day that wildlife was present. Nearly half (48) of all respondents selected their own proximity to bears as the most important indicator, and 18 of respondents selected amount of day that wildlife was present as the most important experience or condition. Both indicators moderately increase the quality of the visitor experience; on a 7-point Likert scale from "extremely decreased the quality of my experience" to "extremely increased the quality of my experience," they scored averages of 5.68 and 5.83 respectively.
- Other potential indicators. Few respondents selected the remaining 18 indicators as the most important, however some conditions were shown to slightly improve the quality of the visitor experience while others had neutral or slightly negative effects. *See page 16 for more results*.
- Fishing indicators. Potential indicators are reported, but the sample of visitors who engaged in fishing is small and results do not reveal any salient indicators.

Soundscape preferences (Page 21)
Results are reported on a 9-point Likert scale from "strongly disagree" to "strongly agree." A score of 5 represents the midpoint.

- Overall. Responses to nine sound-related questions indicate that visitors are not dissatisfied with the current soundscape and agree that it should be preserved/protected.
- Need to restore. The average response to whether the park's soundscape needs to be restored closer to natural conditions was neutral (4.98).
- Need to preserve/protect. Visitors agreed that the park's natural soundscape needs to be preserved/protected (6.60).
- Amount of noise. On average, visitors disagreed that there were too many non-natural or motorized noises (3.78) and that the human-caused noises they heard were inappropriate (3.83). In other words, the amount of noise caused by motorized vehicles is appropriate according to visitor responses.
- Solitude. On average, visitors did not report that sounds interfered with their sense of solitude. They slightly disagreed that their sense of solitude was disrupted by the amount of time they heard motorized noise (4.14), that the noise level of motorized noise (4.24) and that the number of times they heard motorized noise (4.19).
- Expectations. In response to the condition "I was knowledgeable about the types of sounds I would hear at the park prior to my visit," the visitor response was neutral on average (5.07). Visitors disagreed that there was more human-caused noise than they expected (3.56).

Table of Contents

Executive Summary	i
Key Recommendations	ii
Key Findings	iii
Introduction	1
Rationale	1
Objectives	2
Methods	3
Visitor Questionnaires	3
Sampling Design and Locations	3
Results	8
Locations and Activities	8
Demographics	10
Indicators of Quality	13
Results	13
Open-Ended Questions	18
Fishing Indicators	19
Soundscape Preferences	21
Implications for Management	24

Table of Figures

Figure 1: Location of KATM in Alaska	1
Figure 2: Sampling locations in KATM	4
Table 1: Researcher days in each location	*5*
Figure 3: Time spent in park and percent guided visitors	9
Table 2. Visitor activities	9
Table 3. Visitor destinations	*10*
Figure 4: Zip code map of Alaska	11
Figure 5: Zip code map of the contiguous United States	12
Figure 6: Country of origin map	12
Figure 7: Indicators of quality plotted level of influence and importance	14
Table 4: Salient indicators	*15*
Table 5: Group A indicators	*15*
Table 6: Group B indicators	*15*
Figure 8: Reported increases and decreases in visitor experiences	17
Table 7: Responses to "What did you enjoy most about your time in the park?	19
Table 8: Responses to "What did you enjoy least about your time in the park?	19
Table 9: Fishing-related indicators	20
Table 10: Levels of satisfaction with fish catch	20
Table 11: Fish catch conditions relative to expectations	20
Table 12: Perceptions of soundscapes	22
Figure 9: Perceptions of soundscapes	23

Introduction

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 Katmai National Park and Preserve (KATM) (Figure 1). KATM features natural, cultural, and recreational resources that invite a population of visitors to its backcountry and wilderness.

Established in 1918 as a national monument with the purpose of preserving the area around the Novarupta-Katmai eruption, and made a national park through the Alaska National Interest Lands Conservation Act, KATM boasts over 4 million acres of wild landscapes. KATM landscapes includes volcanoes, robust fish and wildlife populations, and backcountry recreational opportunities (National Park Service, n.d.).

Figure 1. *Location of KATM in Alaska*

Rationale

Visitation has posed increasing management concerns at KATM, and park managers are challenged to develop effective and efficient management strategies for addressing important visitor use and impact issues.

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, wilderness visitors and managers may have diverging subjective

evaluations of wilderness quality (Shin & Jackson, 1997; Manning, 2011). 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 & Paradice, 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 is to quantify relationships between visitor use, and resource and social conditions at KATM. This baseline information about backcountry and wilderness visitors (i.e. those in all areas of the park except Brooks Camp) can inform visitor use management and associated planning groups at KATM with the development and implementation of management plans at KATM.

Two phases were identified to inform the primary purpose of the research: 1) development of indicators to evaluate both social and natural resource attributes related to backcountry and wilderness management in general, and the bear viewing experience specifically; 2) measuring thresholds for salient indicators and statistically verifying the preliminary indicators and thresholds, as well as collecting data to determine the relationships between patterns and ecological and social conditions in key locations. This preliminary report presents the results of Phase 1 and will be updated upon completion.

Methods

Visitor Questionnaires

A quantitative visitor questionnaire (Appendix D) was distributed to backcountry and wilderness day use and overnight visitors who visited an area other than Brooks Camp. Sampling for KATM occurred concurrently with sampling for a LACL study using the same survey instrument. Questionnaires included a question about which park was the visitor's primary destination and whether respondents visited both KATM and LACL. All those who indicated KATM as their primary destination or that they visited both parks were included in this report's analyses.

The survey instrument was developed with input from park management. Iterative discussions with park management were integrated throughout the survey-writing process, and a phone conversation with commercial use authorized operators elicited comments on a draft questionnaire, many of which were incorporated into the final instrument.

The questionnaire evaluated indicators of quality for visitors' experiences. Researchers also captured visitors' preferences regarding soundscapes, activities engaged in at KATM, information about sites visited and overnight use, and general demographics using standard U.S. Census Bureau categories. General demographics included zip code of primary residency, age, race, income, and education level. The survey uses best practices for survey construction, such as those set forth by Vaske (2008) and Dillman (2011). To gauge indicators of quality for visitors' experiences, the research team used an approach guided by the Interagency Visitor Use Management Framework (IVUMC, 2016).

In addition to on-site questionnaires, an online version of the questionnaire was solicited using a modified Dillman method (Dillman, 2011). Using this method, visitors were provided with a business card that included both a URL and QR code to access the survey, as well as a unique access code with which researchers are able to track survey completion. Researchers collected an email address and correlated it with each card's access code, and two reminder emails were sent one week and two weeks following business card distribution. In all cases, each intercepted visitor who was 18 or over in age was asked to complete a survey on site or online. In field locations, researchers executed an entry briefing, where they introduced themselves and the research upon the visitors' arrival, when possible. Then, researchers either distributed cards or identified an appropriate time and location for on-site survey distribution and completion.

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).

Sampling Design and Locations

Questionnaires were distributed at nine intercept points, including regional travel corridors, sites in KATM, and sites in LACL. Due to the concurrent nature of sampling at LACL and KATM, visitors who visited any backcountry or wilderness area in at least one of these parks were asked to complete a questionnaire regardless of the intercept location. As some respondents visited

both parks, LACL intercepts are included in the sampling design for this study, but questionnaire items allowed researchers to identify KATM visitors regardless of their intercept location.

To ensure a representative sample while attaining a sufficient sample size, researchers used a stratified random sampling procedure (Vaske, 2008) and distributed surveys at relatively high-use locations across the LACL backcountry and wilderness, as well as in regional travel corridors according to peak use times identified by informal interviews with park staff and visitor resources provided on the park website (NPS, 2018). The sites are: Homer Airport (Homer, AK), Islands & Oceans Visitor Center (Homer, AK), King Salmon Airport (King Salmon, AK), Hallo Bay (KATM), Brooks Camp (KATM), Valley of Ten Thousand Smokes bus (KATM), Upper Twin Lakes/Proenneke Cabin (LACL), Crescent Lake (LACL), and Silver Salmon Creek (LACL). The field season ran from June 25 through August 3, while KATM staff continued to solicit surveys from visitors on the Valley of Ten Thousand Smokes bus beginning July 14 through the end of the summer. Because weather commonly impacts flight schedules, planned surveyor locations were adjusted frequently throughout the season, resulting the schedule reported in Table 1.

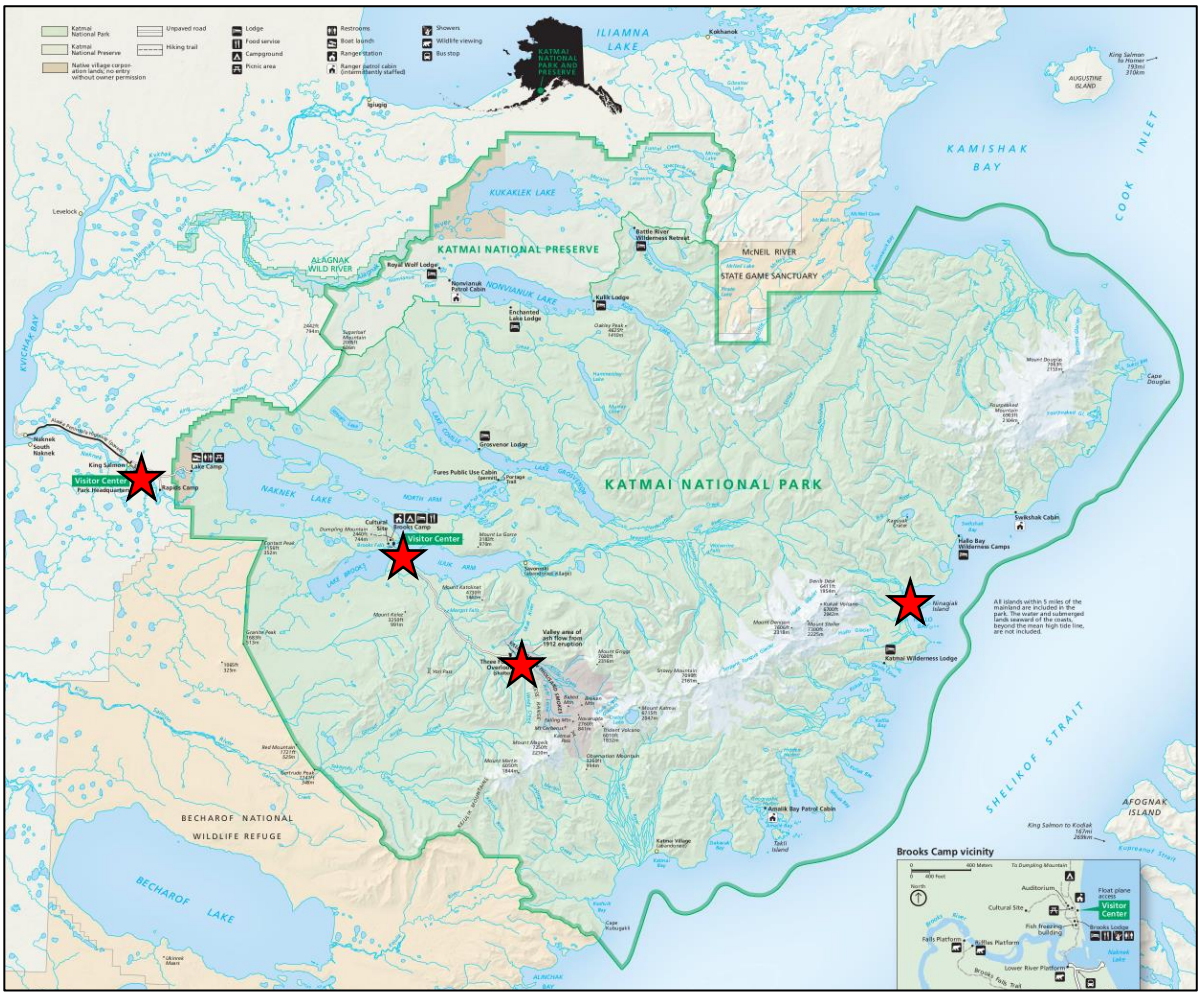


Figure 2. *Sampling locations in KATM*

Table 1. *Researcher days in each location. Numbers indicate the number of Kansas State University and Clemson University surveyors, while NPS refers to park staff distribution.*

	Homer Airport	I&O Visitor Center	King Salmon Airport	Hallo Bay	Brooks Camp	Valley of 10,000 Smokes	Upper Twin Lakes	Crescent Lake	Silver Salmon Creek
6/25/18	2								
6/26/18	2								
6/27/18		2							
6/28/18	1	1							
6/29/18		2							
6/30/18		2							
7/1/18				3					
7/2/18				3					
7/3/18				3					
7/4/18				3					
7/5/18				3					
7/6/18				3					
7/7/18				3					
7/8/18				3					
7/9/18				3					
7/10/18				3					
7/11/18			1		1				
7/12/18			1		1				
7/13/18			1		1				
7/14/18			1			NPS			
7/15/18			1			NPS	1		
7/16/18			1			NPS	1		
7/17/18			1			NPS	1		
7/18/18			1			NPS	1		
7/19/18			1			NPS	1		
7/20/18			1			NPS	1		
7/21/18						NPS			
7/22/18						NPS		1	1
7/23/18						NPS		1	1
7/24/18						NPS		1	1
7/25/18						NPS		1	1
7/26/18						NPS		1	1
7/27/18						NPS		1	1
7/28/18						NPS		1	1
7/29/18						NPS		1	1
7/30/18			1			NPS			1
7/31/18			1			NPS			1
8/1/18			1			NPS			1
8/2/18			1			NPS			
8/3/18			1			NPS			
Total	**5**	**7**	**15**	**30**	**3**	**N/A**	**6**	**8**	**11**

In KATM, researchers were on site at two locations: Brooks Camp and Hallo Bay. At Brooks Camp, visitors were intercepted opportunistically at the picnic area, on platforms, and on trails. These visitors were thoroughly screened, and only those who had visited other parts of KATM or LACL, including overnight stays in the Valley of Ten Thousand Smokes, were offered a questionnaire.

In Hallo Bay, researchers intercepted visitors primarily on the north beach. The shore of Hallo Bay is primarily oriented north-south and is bisected by Middle Creek. Visitors rarely cross from one side of the creek to the other, particularly because it is tidally influenced and difficult to cross during high tides. Day-use visitors typically land on the beach, engage in a bear safety

orientation, and then proceed to another part of Hallo Bay. Visitors also resided overnight on boats docked off shore, coming to land for scattered periods of time throughout the day. Depending on the preferences of guides or other logistical considerations, visitors were generally intercepted in one of two ways. Most commonly, visitors were intercepted upon arrival or departure and solicited for an online questionnaire (we gave them a business card with a URL, and they gave us an email address). Some overnight visitors were approached upon arrival and provided an entry briefing where researchers introduced the study, then solicited with paper questionnaires upon departure.

In LACL, researchers were on site at three locations. In Upper Twin Lakes/Prennoeke's Cabin, one researcher was present for 6 days. The researcher distributed surveys at the cabin site, where NPS rangers provide a guided tour. When visitors arrived at the cabin, the ranger met them on the beach where planes land or boats dock, during which time the researcher briefed the visitors about the study. After the visitors completed their activities at the site, they returned to their planes to depart and the researcher distributed surveys. Additionally, the NPS rangers monitor a campsite about half a mile away from the cabin. When visitors were present at the campsite, the researcher intercepted them there.

One researcher was present at Silver Salmon Creek for 11 days. There are two main beach areas where visitors arrive in Silver Salmon Creek, bisected by a creek. Day use visitors arrive on one of these beaches and recreate throughout the area. The ability for planes to land and take off on these beaches is also tidally influenced, leading to a restricted spatiotemporal window of visitor activity. Additionally, the bisecting creek is tidally influenced, which restricts the ability for researchers to cross during certain times. The length of the beach and the limited window during which planes arrive and leave, make intercepts on foot challenging, so when possible, the researcher joined an NPS ranger during ATV roving patrol. When not possible, the researcher remained in an area of the beach where planes land most often. Additionally, two lodges operate in Silver Salmon Creek, serving overnight visitors who engage in activities such as bear viewing and fishing. By request of the lodge owners, these visitors were intercepted on the premises of one of the lodges. Intercepts mainly occurred during an indoor pre-dinner social hour and occasionally in common areas between cabins.

One researcher was present in Crescent Lake for 8 days. There is one beach location where visitors primarily arrive via aircraft and move throughout Crescent Lake on fishing vessels. The visitor groups generally arrive on the beach location, spend a notable amount of time fishing downriver from the beach location, and conclude their trip by returning to the beach location to depart Crescent Lake. The researcher distributed surveys to visitors during the time period at the end of their trip that involved their return to the beach location and their departure. Additionally, the researcher intercepted visitors at a lodge on site during meal times.

Homer and King Salmon Airport intercepts occurred in the terminal/gate area of each airport. The airports are very small, and researchers were able to monitor the entire waiting area and approach most flyers. Travelers were thoroughly screened to assess whether: (a) they visited either KATM or LACL and (b) they visited some place other than Brooks Camp, i.e. a backcountry or wilderness area. Visitor intercepts at the Islands & Oceans Visitor Center employed the same screening process and occurred in the main lobby area of the building.

During regional travel corridor intercepts, researchers approached travelers at random and asked a series of qualifying questions to determine whether the person visited LACL:

1) Have you visited either KATM or LACL within the last 30 days?
    a. If no → are you planning to visit either destination during your visit?
    b. If yes → did you (or are you planning to) visit an area other than Brooks Camp?

The question regarding Brooks Camp was often used because Brooks Camp is the only area of the park not included in this study. Brooks Camp was typically a name that participants recognized and was a useful and straightforward way to identify individuals who had visited backcountry or wilderness areas.

In some cases, these qualifying questions were clear to respondents. Other times, people could not answer these questions either because they did not know the names of the locations they visited, or they could not remember (*See results regarding locations and activities for more*). In these cases, researchers would attempt to identify whether the individual visited an area in either LACL or KATM by asking alternative questions regarding the place they visited, activities they engaged in, or infrastructure present. For example, researchers may have asked whether the place had bear viewing platforms and a visitor center, which are only present in Brooks Camp.

Those visitors that had visited either or both parks in the past 30 days were asked to complete the questionnaire, while those who were planning to visit were asked to take a business card and provide an email address for online completion.

Results

During sampling, 512 visitors completed a questionnaire, achieving a 5-confidence interval at the 95-confidence level. The response rate for on-site questionnaires was 93. Of the 205 online surveys sent, 136 were completed, yielding a response rate of 73. There was only one refusal to provide an email address.

This completion amount represents individual visitors (every person in the group was asked to complete a questionnaire). 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 Katmai National Park and Preserve (KATM) and Lake Clark National Park and Preserve (LACL).

Of the 512 respondents, 299 selected KATM as their primary destination, and another 36 selected LACL but indicated that they visited both parks (55 total respondents visited both parks). Therefore, 355 respondents visited KATM. Of these respondents, 80 completed online questionnaires. This achieves a 5-confidence interval at the 95-confidence level.

Most of the analyses in this report includes only respondents who visited KATM, including demographic information, soundscape preferences, and analysis of open-ended questions. However, data from visitors to either or both parks are combined in the analysis of potential indicators. Figures, tables, and analysis that include combined data are noted.

Locations and Activities

Of the 321 respondents who reported the number of days spent in the park, 31 were single-day users. Fifty-nine percent of visitors spent between 2-7 days, and 10 of respondents spent seven or more days in the park (Figure 3). The largest groups of overnight users who reported their accommodations camped in the park (32) or stayed in private cabins or businesses in the park (16 Brooks Lodge, 19 other). Fourteen percent of multi-day visitors reported staying outside of the park. Forty-six percent of visitors reported being accompanied by a professional or commercial guide during most of their time in the park.

When asked to indicate their primary source for learning about the park prior to the visit, the largest group of visitors selected “other” (35). The next largest groups selected the official park website (17) or a guide service (15). The remainder were split between the explore.org bear cameras, social media, television or film, travel agency, and YouTube.

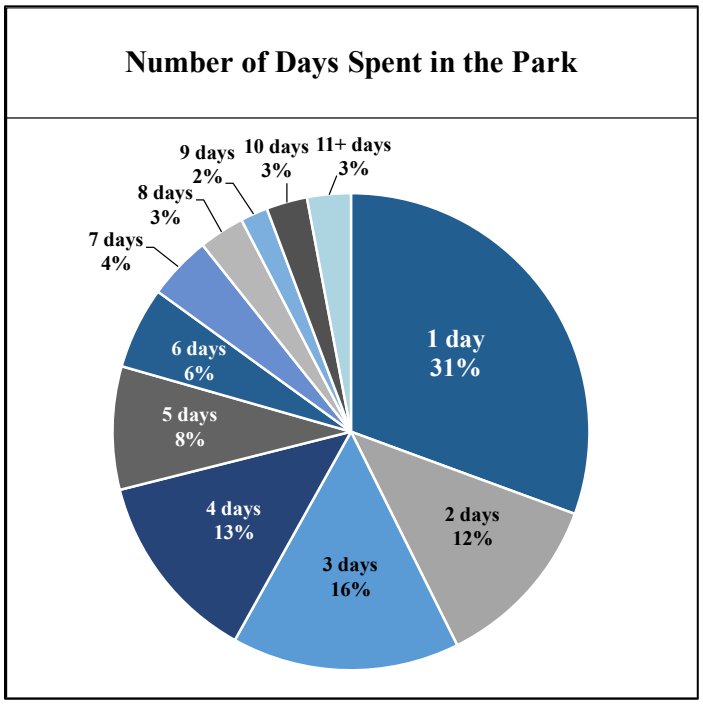


Figure 3. *Length of time spent in park*

Of the 85 visitors who selected "other," 46 specified word of mouth or specific people. 19 of the "other" responses specified internet sources other than the official park website, 12 specified past experience in the park, and 9 indicated books or newspapers. The remaining people who specified another source indicated businesses, photography resources, or indicated that they are an Alaska resident who has always known about the park.

The most common main reason for visiting the park was bear watching (63), and visitors were also asked to select all activities engaged in (Table 2). 13 of respondents did not answer this question.

Table 2. *Visitor activities*

Activity	**Percent of Sample**	
	Select all activities participated in	***Main reason***
Bear Watching	**92.8**	**63.1**
Photography	**66.3**	10.7
Fishing	21.5	7.6
Backcountry Camping	18.2	5.5
Backcountry Hiking	32.8	3.1
Part of Organized Tour	19.4	2.8
Flightseeing	23.3	2.1
Boating	14.9	0.7
Hunting & Trapping	0.0	0.0
Other	6.0	4.5

Respondents were also asked to report which locations they visited (Table 3). Hallo Bay, a survey intercept, was the commonly reported (17) location visited. 28 selected that they did not visit any of the areas listed, 28 selected "other," and 18 indicated that they did not know the location names of the places they visited. The high number of "others" may be demonstrative of visitors who visited Brooks Camp, and visitors to the Valley of Ten Thousand Smokes would have selected "I did not visit any of these areas".

When asked if the majority of their bear viewing took place at Brooks Camp, 68 of respondents selected "yes," 27 "no," and 4 indicated that they did not view bears during their visit. During the screening questions prior to survey distribution, researchers identified whether a visitor was in an area *other than Brooks Camp*, and only distributed surveys to those who were. Therefore, the high number of visitors who indicated that the majority of their bear viewing occurred at Brooks Camp suggests that visitors to backcountry and wilderness areas are also visiting Brooks Camp as part of a multi-destination experience in the park.

Table 3. *Visitor destinations*

Location	**Percent of Sample**
American Creek (KATM)	1.2
Chinitna Bay (LACL)	3.3
Crescent Lake (LACL)	2.4*
Geographic Harbor/Amalik Bay (KATM)	1.2
Hallo Bay (KATM)	17.0*
Kukak Bay (KATM)	5.4
Kukaklek Outlet (KATM)	2.1
Kulik River (KATM)	5.4
Moraine Creek/Funnel Creek (KATM)	3.0
Silver Salmon Creek (LACL)	2.7*
Twin Lakes/Proenekke's Cabin (LACL)	10.7*
Other	27.5
I did not visit any of these areas	28.1
I do not know the locations names of the places I visited	17.6

**Survey intercept locations*

Overall Demographics of Visitors

The average age of respondents was 52, and the median age was 54. There were slightly more male visitors, with 54 respondents identifying as male, 46 identifying as female. Forty-five percent of respondents reported attaining a graduate or professional degree, 29 four-year college graduate, 7 two-year college graduate, 10 some college, 7 high school graduate or less (4 indicated that they do not wish to answer). The sample had a relatively even distribution of household incomes, with 18 of participants indicating an income of $200,000 or more, 19 selecting $150,000 to $199,999, 12 selecting $100,000 to $149,000, 11 selecting $75,000 to $99,000, 14 selecting $50,000 to $74,999, and 8 selecting incomes lower than $50,000. Most

respondents (88) self-identified as white, and 3 self-identified as Hispanic or Latino/Latina, 3 declined to answer, 2 self-identified as Asian, and 2 of respondents self-identified as other races. Respondents primarily originated from the United States, with a relatively even spread throughout the contiguous U.S. (Figures 4 and 5). Seventeen percent of respondents originated from Alaska. International visitors comprised 19 of the sample (63 respondents) and were international (Figure 6).

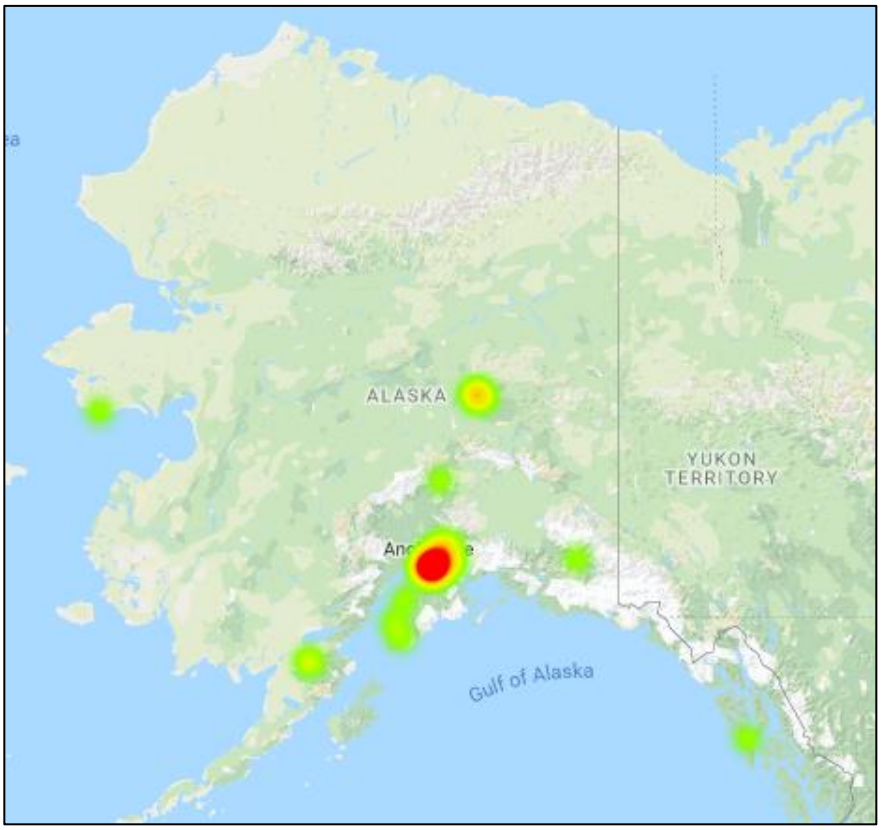


Figure 4. *Zip code map of Alaska*

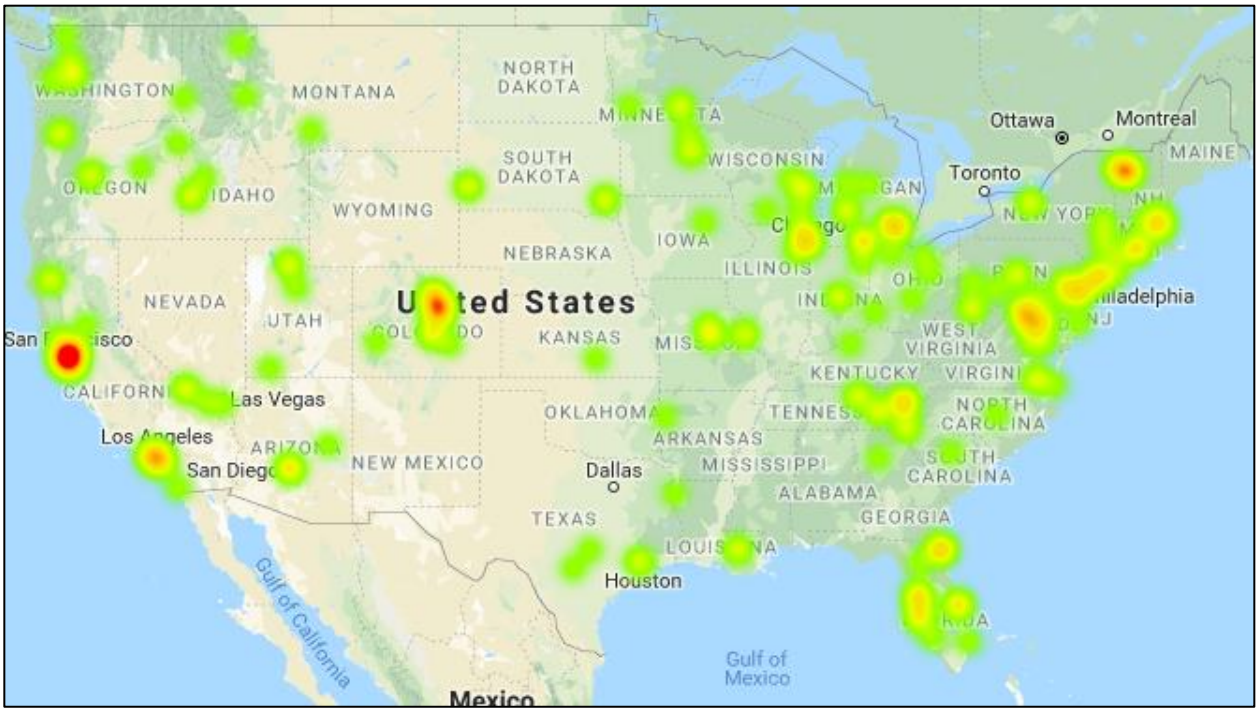


Figure 5. *Zip code map of the contiguous United States*

Figure 6. *Countries of origin reported in the sample*

Indicators of Quality

Visitors were asked to assess 20 experiences and conditions for the level at which they increased or decreased the quality of their experience. Additionally, respondents were asked to select the most important experience or condition that influenced the quality of their experience.

In order to increase robustness, questionnaire responses from both LACL and KATM visitors were combined to analyze potential indicators of quality. Independent t-tests were conducted to evaluate whether visitors who indicated each park as their primary destination had statistically significant differences in their responses to the first set of questions, which asked respondents to indicate the level at which each condition increased or decreased the quality of their experience.

Of the 20 potential indicators included in the questionnaire, eight were statistically different between groups at the 0.05 level:

- Amount of the day that wildlife was seen or present
- Amount of time other visitors are heard outside my own travel party
- Other visitors' proximity to bears, number of other people viewing a bear
- Number of planes landing or taking off close to me
- Amount of time other visitors are seen outside my own travel party
- Number of other people encountered in one day
- Number of planes heard in one day.

To determine whether there is a statistically significant difference between the groups' responses when asked to select the most important indicator, a Pearson Chi-squared analysis was conducted (Appendix B). The Pearson Chi-squared value is .006, which could indicate that there is a significant association between respondents' primary destination and the condition they selected as the most important. However, because most of the potential indicators were selected by very few respondents, the test may not be a reliable indicator of statistical differences.

When comparing the two samples, statistically significant differences exist. However, the sample populations are small, the differences in means are small and do not change the managerial implications, and the same indicators emerge as salient whether analysis is done for KATM alone, LACL alone, or both parks combined. However, combining samples creates a more robust set of data, particularly considering the parks offer similar recreational opportunities. Therefore, for the purposes of this preliminary report, a decision was made to combine questionnaire responses regarding potential indicators from both KATM and LACL visitors.

****Indicates figures or tables that report data from both KATM and LACL visitors**

Results

Figure 7 plots all 20 indicators according to these two dimensions across both LACL and KATM. The x-axis displays the mean value across all respondents on a 7-point Likert scale, where 1 represents a condition that extremely decreased the quality of the visitor's experience, and 7 extremely increased the quality of their experience. Selecting "4" indicated that the condition neither decreased nor increased the quality of their experience.

The two most salient indicators combined were selected by 65 of respondents as the most important experience or condition that influenced the quality of their experience. The remaining 35 of respondents identified one of the remaining 18 experiences as the most important experience or condition that influenced the quality of their experience.

While very few respondents selected conditions other than the two salient indicators as their most important experience or conditions, it is useful to understand to what degree each condition increases or decreases the quality of visitor experiences. The number of cases outside the two salient indicators were too small to conduct a reliable cluster analysis, however two groups appear to emerge (Figure 7).

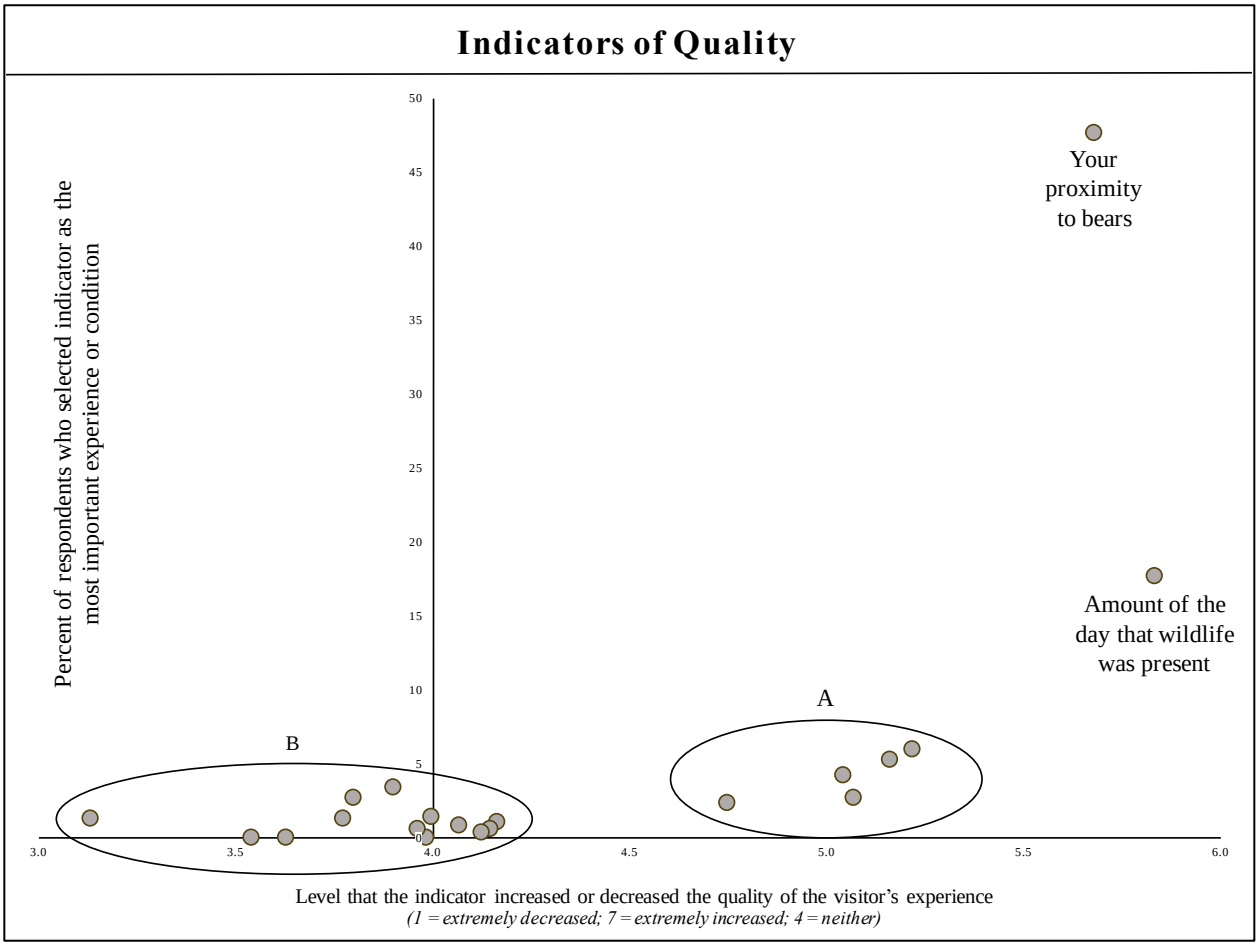


Figure 7. *Indicators of quality plotted level of influence and importance***

The most salient indicators (Table 4) were the visitors' own proximity to bears, and the amount of the day that wildlife was present. They influenced the quality of visitors' experiences similarly; visitors indicated that these experiences and conditions moderately to extremely increased the quality of their experience. Nearly half (47) of all respondents selected their own proximity to bears as the most important indicator, and 17 of respondents selected amount of day that wildlife was present as the most important experience or condition. Both of these conditions moderately increased the quality of the visitor experience.

Conditions in Group A (Table 5) slightly increase the quality of visitors' experiences and have low levels of importance overall. Conditions in Group B (Table 6) are reported to have a neutral or slightly negative influence on visitors' experiences and a very low level of importance.

Table 4. *Salient indicators***

Salient indicators		
Indicator	***Mean level of influence****	***most important (frequency)***
Your proximity to bears	5.68	47.6 (223)
Amount of the day that wildlife was present	5.83	17.7 (83)

Table 5. *Group A indicators***

Group A		
Indicator	***Mean level of influence****	***most important (frequency)***
Amount of time without human produced noise	5.22	6.0 (28)
Interacting with a park ranger	5.16	5.3 (25)
Amount of time without hearing other visitors	5.07	2.8 (13)
Amount of time without seeing other visitors	5.04	4.3 (20)
Behavior of other guides	4.75	2.4 (11)

Table 6. *Group B indicators***

Group B		
Indicator	***Mean level of influence****	***most important (frequency)***
# of planes seen in one day	4.16	1.1 (5)
# of planes parked at one location	4.15	0.6 (3)
Amount of litter seen	4.12	0.4 (2)
Amount of time other visitors are seen	4.07	0.9 (4)
# of planes heard in one day	4.00	1.5 (7)
Amount of time other visitors are heard	3.98	0.0 (0)
Other visitors' proximity to bears	3.96	0.6 (3)
# of other people encountered in one day	3.90	3.4 (16)
# of other people viewing a bear	3.80	2.8 (13)
# of planes landing or taking off close to me	3.77	1.3 (6)
# of campsites within sight of me	3.63	0.0 (0)
Amount of sound from other campsites around me	3.54	0.0 (0)
# of visitors breaking wildlife viewing rules	3.13	1.3 (6)

**Measured on a 7-point scale, ranging from extremely decreased (1) to extremely increased (7) the quality if their experience. A response of 4 indicates that the condition neither increased nor decreased the quality of their experience.*

Figure 8 shows all 20 conditions and experiences that visitors were asked to assess on a 7-point Likert scale from, “extremely decreased the quality of my experience” (coded as 1) to “extremely decreased the quality of my experience” (coded as 7) across both KATM and LACL. A response of 4, displayed as grey in the figure, indicates that it neither increased nor decreased the visitor’s quality of experience. Next to each condition is a mean value and standard deviation; this is the mean across all valid responses. This does not include visitors who selected “did not experience,” and the percent of visitors who selected that option is displayed in the right-most column. The remaining percentages in the figure represent the proportion of visitors who selected each response *out of the respondents who selected a 1-7 response*.

From left to right, the colors represent percent responses on the 1-7 scale. The position of the grey bar (respondents who indicated that the condition neither increased nor decreased the quality of the experience) displays the difference in the number of respondents who indicated that the experience was positive or negative; if the bar is to the left of center more visitors found the experience to be positive, and if it is right of center more visitors found the experience to be negative. This is different than a mean, because it does not weight for the degree to which the respondents’ quality of experience was influenced. This is displayed in the color tone for each bar; more dark tones display more extreme increases or decreases.

For example, the means for number of planes parked in one location (AAOT) and amount of litter seen are very similar and close to neutral. However, from the placement of the grey bar it can be understood that more visitors thought AAOT positively impacted the quality of their experience relative to those who thought it negatively impacted their experience, but more respondents were neutral and a large number of the those who believed it increased the quality of their experience only believed it was a slight increase. In contrast, responses to the amount of litter were more evenly spread between positive and negative responses.

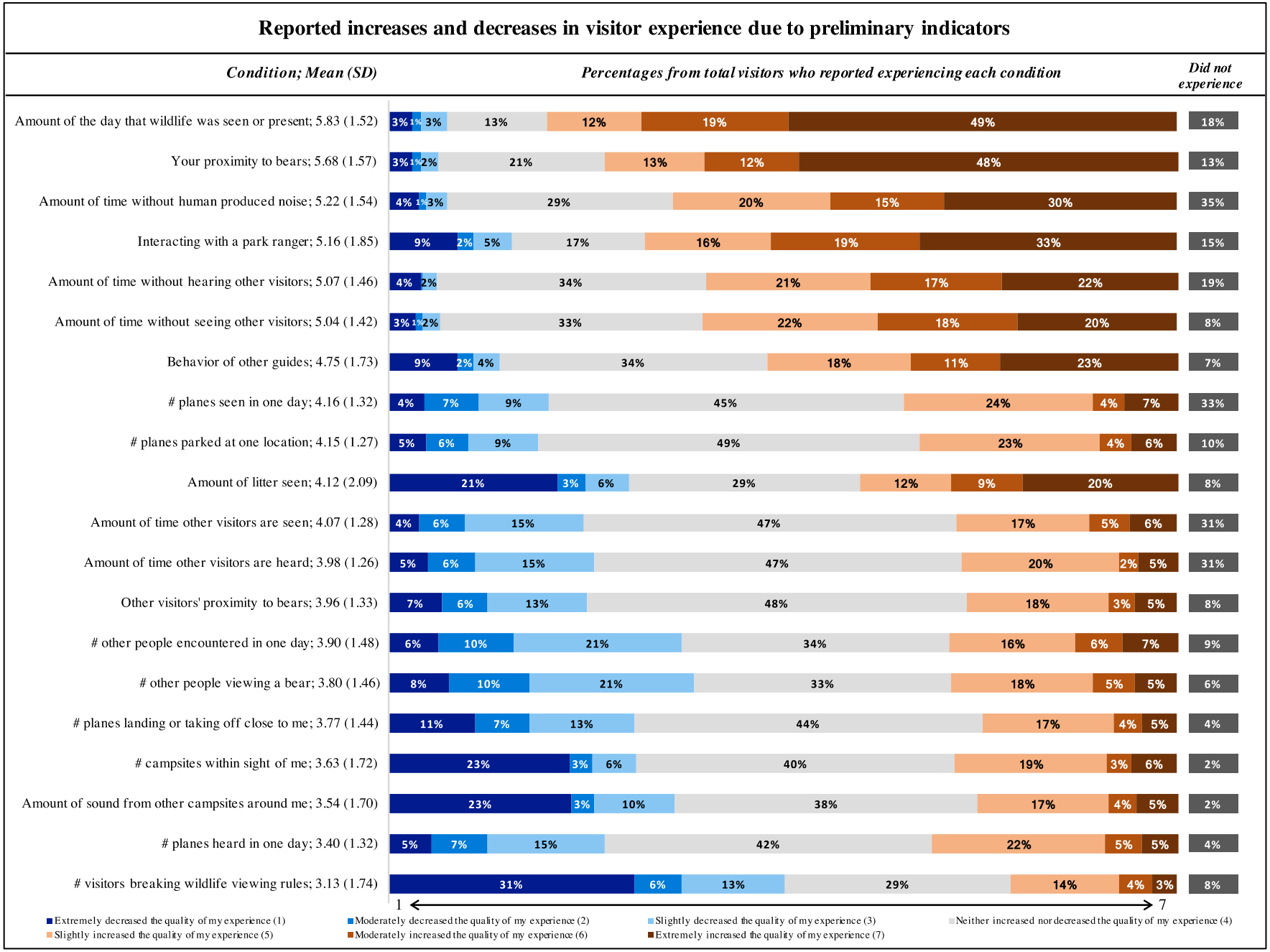


Figure 8. *Distribution of responses to each indicator on a 7-point Likert scale from, extremely increased to extremely decreased the quality of the visitors' experience***

Open-Ended Questions

The questionnaire also included two open ended questions: “What did you enjoy most about your time in the park?” and “What did you enjoy least about your time in the park?”. Responses to the both questions were manually coded. In cases where respondents described multiple elements of their experience, the response was coded according to the first condition mentioned (Tables 7 and 8). Results reported in this section reflect only those respondents who visited KATM.

For responses to the first question, regarding the visitors’ most enjoyable experience, categories were distance to bear (DTB), presence of wildlife (POW), environment, bear viewing, fishing, or other. Responses coded as DTB involved nearness to bears. POW included responses that directly involved the density of wildlife or amount of wildlife seen, as well as responses that simply stated a wildlife species, usually bear. Responses coded as environment include descriptions of natural beauty, landscapes generally, solitude, or quietness. Bear viewing responses directly reference watching or viewing bears, and fishing responses directly reference sport fishing. Responses coded as other include references to activities other than fishing or bear viewing, infrastructure, people or groups of people, and more.

Of the 329 KATM visitors who replied to the question regarding their most enjoyable experience: 33 indicated bear viewing, 24 indicated presence of wildlife, 20 indicated environment, 15 indicated other, 5 indicated fishing, and 4 indicated distance to bears. Of the 107 respondents that indicated bear viewing, 11 (12 respondents) described bear viewing at Brooks Camp and 10 (11 respondents) specifically mentioned viewing bears in natural environments or engaging in natural behaviors. Of the 79 respondents who indicated POW, 89 specifically mentioned bears. These results align with quantitative data elicited in response to potential indicators, described in the previous section of this report and indicate that questionnaire responses are internally consistent.

In response to the question about their least enjoyable experience, 13 of survey respondents did not write anything and 28 of respondents indicated that the question was not applicable or that there was nothing they did not enjoy. Responses were categorized as follows: weather and insects (23); Brooks Camp logistics (10), which included responses related to wait times, behavior of concessionaire staff, NPS staff and volunteers, or similar; crowding of people or planes (9.0); quality or availably of infrastructure such as electricity or hiking trails (4); or they indicated that they did not have enough time in the park (3). The remaining responses (9) are considered “other,” and they include a wide variety of conditions regarding soundscapes, costs, nearness to bears and bear safety concerns, and more.

Table 7. *Responses to question, "What did you enjoy most about your time in the park?"*

Category	**Percent of Sample (Frequency)**
Bear viewing	32.5 (107)
Presence of wildlife	24.0 (79)
Environment	19.8 (65)
Fishing	4.6 (15)
Distance to bears	4.0 (13)
Other	15.2 (50)

Table 8. *Responses to question, "What did you enjoy least about your time in the park?"*

Category	**Percent of Sample**
Nothing	28.1 (94)
Weather and insects	23.3 (78)
Brooks Camp logistics	10.1 (34)
Crowding	9.0 (30)
Infrastructure	8.4 (28)
Time	3.3 (11)
Blank response	13.1 (44)
Other	9.3 (31)

Fishing Indicators

In addition to the indicators for general visitor experience, visitors who fished were asked to respond to 13 experiences and conditions. While some respondents skipped questions, between 60 and 62 respondents answered questions on whether and to what degree the conditions increased or decreased the quality of their experience. On a 7-point Likert scale, where 1 represents a condition that extremely decreased the quality of the visitors' experience and 2 represents a condition that extremely increased the quality of the visitors' experience, mean values for all 13 potential indicators were between 3.32 and 5.36 (Table 9). Respondents who fished were also asked to select the most important fishing-related condition that influenced the quality of their fishing; 54 respondents selected a condition.

Additionally, if visitors reported fishing, they were asked to answer questions related to catch. The mean number of fish respondents reported catching was 10.47 (standard deviation: 10.70). On a 5-point scale from extremely dissatisfied to extremely satisfied (3 = neither satisfied nor dissatisfied), responses regarding catch type, frequency, and quality were slightly positive or neutral (Tables 10). Finally, respondents who fished were asked how four catch-related conditions aligned with their expectations on a 5-point scale from significantly less than expected to significantly more than expected (3 = neither less or more than expected). Mean responses were slightly less than neutral (Table 11).

Table 9. *Fishing-related indicators*

Fishing-Related Indicator	Mean (SD) influence*	most important (Frequency)
# of bear encounters that you experienced during one day that interfered with your angling efforts	4.46 (1.71)	17.0 (8)
# of other boats visible while fishing	4.40 (1.21)	12.8 (6)
Amount of time you waited to access a desirable fishing location due to the presence of other anglers	4.00 (1.96)	12.8 (6)
Condition of plants and vegetation surrounding your fishing location(s)	5.36 (1.63)	10.6 (5)
Proximity of other anglers to you during active fishing time	4.37 (1.73)	10.6 (5)
# of fish you caught with visible scarring from previous catches	3.90 (1.56)	10.6 (5)
Amount of time other anglers were visible to you	5.02 (1.69)	6.4 (3)
# of other anglers that you encounter during a single day of fishing	4.52 (1.71)	6.4 (3)
# of times in one day you were not able to access a desirable fishing location due to the presence of other anglers	3.56 (1.52)	6.4 (3)
# of other planes visible while fishing	4.42 (1.44)	2.1 (1)
# of times in one day you were not able to access a desirable fishing location due to the presence of other visitors who were not fishing	3.69 (1.93)	2.1 (1)
Amount of angling related litter seen in one day (e.g., discarded fishing line)	3.32 (1.9)	2.1 (1)
Condition of trails surrounding your fishing location(s)	4.73 (1.36)	0.0 (0)

Table 10. *Levels of satisfaction with fish catch*

Condition	Mean (SD) satisfaction*
Species or type of fish I caught	4.25 (0.77)
Size of the fish I caught	4.18 (0.83)
Number of fish caught	4.16 (0.90)
Frequency of catching fish	4.03 (1.00)
Number of fish seen with visible scarring/damage from catch and release	3.50 (0.98)

Table 11. *Fish catch conditions relative to expectations*

Condition	Mean (SD) expectation*
Frequency of catching fish	3.42 (0.91)
Species or type of fish I caught	3.34 (0.79)
Number of fish caught	3.33 (0.85)
Size of fish I caught	3.33 (0.77)

**Measured on a 7-point scale, ranging from extremely decreased (1) to extremely increased (7) the quality if their experience. A response of 4 indicates that the condition neither increased nor decreased the quality of their experience.*

Soundscape Preferences

Because responses to nearly all questions regarding soundscape preferences were statistically different between respondents who selected either LACL or KATM as their primary destination (Appendix B), results in this section include only respondents who reported visiting KATM.

Respondents indicated their agreement with statements regarding soundscapes on a 9-point Likert scale, from strongly agree to strongly disagree. On average and overall, visitors are satisfied with the current soundscape. The average response to whether the park's soundscape needs to be restored closer to natural conditions was neutral (4.89), and visitors agreed that the natural soundscape needs to be preserved/protected (6.60).

Visitors disagreed that there were too many non-natural or motorized noises (3.78) and that the human-caused noises they heard were inappropriate (3.83). On average, visitors slightly disagreed that the amount of time they heard motorized noise interfered with their sense of solitude (4.14), that the noise level of motorized noise interfered with their sense of solitude (4.24), and that the number of times they heard motorized noise interfered with their sense of solitude (4.19). Taken together, these results suggest that visitors are satisfied with current soundscape conditions and do not perceive sounds to interfere with their sense of solitude.

In response to the statement, "I was knowledgeable about the types of sounds I would hear at the park prior to my visit", the visitor response was neutral on average (5.07). Visitors disagreed that there was more human-cause noise than they expected (3.56).

Figure 9 and Table 12 display responses to all soundscape conditional statements on a 9-point Likert scale from, "strongly disagree" to "strongly agree." Responses to questions regarding soundscape conditions and preferences were combined across both KATM and LACL.

Figure 9 should be interpreted similarly to Figure 8. Next to each condition is a mean value and standard deviation; this is the mean across all valid responses. From left to right, the colors represent percent responses on the 1-9-point scale. The position of the grey bar (respondents who selected the midpoint on the 9-point scale) displays the difference in the number of respondents who indicated that the experience was positive or negative; if the bar is to the left of center more visitors found the experience to be positive, and if it is right of center more visitors found the experience to be negative. This is different than a mean, because it does not weight for the degree to which the respondents' quality of experience was influenced. This is displayed in the color tone for each bar; more dark tones display more extreme increases or decreases.

Table 12. *Percent of respondents who agree or disagree with statements about soundscapes in the park*

	Mean; SD	**Strongly Disagree (1)**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Strongly Agree (9)**
The park's soundscape needs to be preserved/protected	*6.74; 2.23*	4.1	1.6	2.8	3.5	20.3	10.4	10.4	13.9	32.9
I was knowledgeable about the types of sounds I would hear at the park prior to my visit	*5.08; 2.45*	8.9	5.4	6.4	7.3	39.6	8.0	6.1	8.3	9.9
The park's soundscape needs to be restored closer to natural conditions	*5.12; 2.22*	12.5	6.1	5.1	9.0	32.5	6.4	8.7	6.1	13.5
The noise level of motorized sounds I heard interfered with my sense of solitude	*4.26; 2.17*	16.4	11.0	6.9	7.3	30.6	13.9	6.6	2.8	4.4
The noise level of motorized sounds I heard interfered with my sense of solitude	*4.37; 2.55*	16.4	11.0	6.9	7.3	30.6	13.9	6.6	2.8	4.4
The number of times I heard motorized noise interfered with my sense of solitude	*4.33; 2.22*	17.4	10.8	7.0	4.7	34.8	13.9	5.4	2.2	3.8
The human-cause noise I heard are inappropriate sounds to hear while at the park	*4.06; 2.15*	17.7	13.0	9.5	6.0	34.5	6.0	7.9	2.5	2.8
There were more human-caused noises than I expected at the park	*3.74; 2.12*	22.4	12.1	7.0	10.9	29.7	7.3	4.8	3.5	2.2
The park has too many non-natural or motorized noises	*3.86; 2.17*	21.9	14.1	10.6	6.4	32.2	5.5	4.5	2.6	2.3

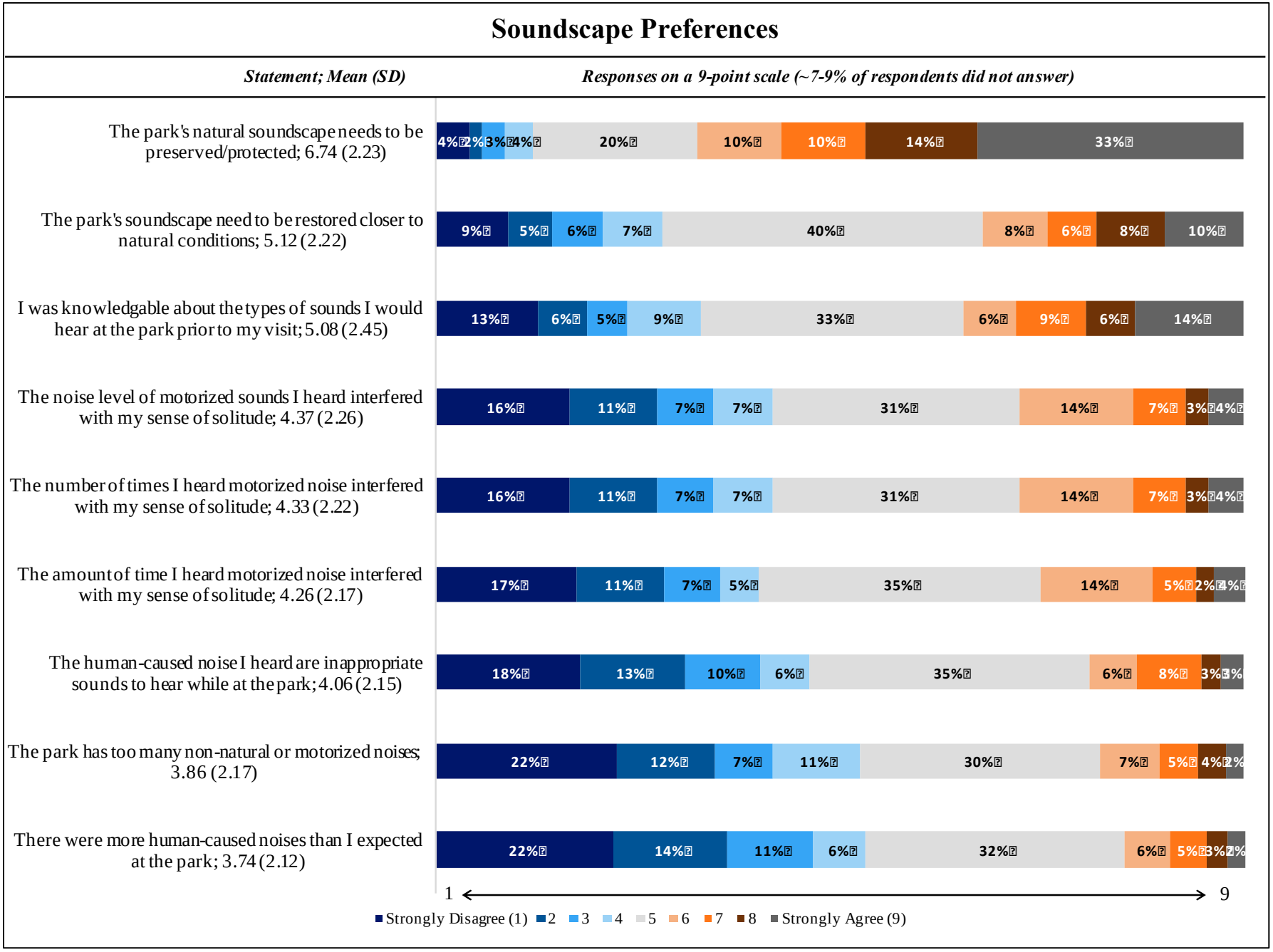


Figure 9. *Distribution of agreement to soundscape conditions on a 9-point Likert scale from, strongly agree strongly disagree.*

Implications for Management

Threshold Identification

This report represents initial stages of visitor use management using an indicators and thresholds framework and is aligned with the Visitor Use Management Framework (IVUMC, 2016). According to the VUM framework, 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 (IVUMC, 2016). Development of indicators will guide the next phase of research, which will use an approach based on Normative theory to develop thresholds for key indicators.

Normative theory 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. 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).

Soundscape Preferences

Indicators related to soundscapes did not emerge as salient owing to the low number of respondents who selected them as the more important experience or condition to influence their experience. However, the amount of time visitors experienced without human produced noise significantly increased the quality of visitors' experiences. Aside from the two salient indicators, this indicator most improved the quality of respondents' experiences.

Researchers and managers may consider developing this condition into an indicator and identifying associated thresholds in the next phase of research. The preliminary investigation of

soundscape preferences in this report reveals that while visitors are satisfied with the current soundscapes, they agree that the current conditions should be protected. As suggested in the key recommendations section of this report, continued monitoring of present soundscapes conditions aligns with reported visitor preferences. Additionally, KATM may consider continuing to limit increases in artificial sounds.

Appendix B: LACL NPP Preliminary Research Report 2017-2018

Visitor Use and Associated Indicators at Lake Clark National Park and Preserve

2017-2018

Preliminary Research Report

Project Report Prepared by (listed alphabetically):

Project Directors and Principle Investigators
Matthew T.J. Brownlee, Ph.D.[1]
Ryan L. Sharp, Ph.D.[2]

Project Coordinator
Dani T. Dagan[2]

[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 was provided by Sarah C. Jackson and Tyler Cribbs in the Park Management and Conservation Lab at Kansas State University.

Executive Summary

The purpose of this research was to gather information to help support visitor use management and planning at Lake Clark National Park and Preserve (LACL). Specifically, this research summary is intended to inform and guide NPS managers in developing indicators of quality for monitoring backcountry day use and overnight visitor experiences and provide sustainable and appropriate visitor experiences and visitor uses in the park. The objectives of this study include: 1) evaluate potential indicators for their importance to visitors and the degree to which they increase or decrease the quality of visitors' experiences and 2) gather baseline information about visitors' soundscape preferences.

The preliminary results can be used to guide the next phase of research. Specifically, this research summary is intended to inform and guide NPS managers in developing indicators of quality for monitoring backcountry overnight and day use visitor experiences and provide sustainable and appropriate visitor experiences and visitor uses in the park. Future research will develop thresholds for important indicators, and the results can help guide visitor use management and planning.

Using quantitative questionnaires, this research summary describes information about the conditions that have the greatest influence over visitor experiences in LACL. Researchers distributed visitor questionnaires at nine intercept areas both in LACL and in regional travel corridors. In addition to on-site questionnaires, an online version of the questionnaire was solicited in the same intercept areas. Results are presented for data relating to visitor demographics and behaviors, indicators of quality, and soundscape preferences.

The report is organized in the following sections: 1) Introduction and Objectives; 2) Methods; 3) Results related to demographics and behavior; 4) Results related to indicators of quality; 5) Results related to soundscapes.

Key Recommendations

- Consider adopting the following indicators for monitoring. These indicators emerged as salient based on visitor responses to potential conditions or experiences, based on both the degree to which it improved their experience and the number of respondents who identified it as the most important influence on the quality of their experience. Also consider measuring thresholds for the following (*see IVUMC, 2016*).
    1. Visitors' own proximity to bears
    2. Amount of day that wildlife is present
- Consider adopting indicators and establishing thresholds for conditions related to fishing. The following five indicators were selected most often as the most important condition or experience that might influence the quality of a fishing experience in the park.
    6. Conditions of trails and vegetation surrounding fishing locations
    7. Number of other anglers encountered during a single day of fishing
    8. Number of bear encounters experienced during one day that interfered with angling efforts
    9. Amount of time waiting to access a desirable fishing location due to the presence of other anglers
    10. Proximity of other anglers to survey respondent during active fishing time
- As 40% of respondents indicated that their source for learning about the park prior to their visit was different from those listed on the questionnaire (e.g. online sources other than the official website), consider investigating these sources further.
- Because a large majority of visitors indicated that they spent the majority of time in the park with a professional guide, and because overnight visitors largely resided in lodges within the park, continue working closely and positively with commercial use authorized operators.
- Continue considering soundscapes and natural sounds a priority. Because visitors are both satisfied with the soundscape and show a preference for preserving it, consider limiting increases in these mechanisms (e.g. aircraft traffic, motorized boats). Additionally, measuring the current soundscape can serve as an important baseline, especially considering visitor satisfaction with present conditions.
- Consider informing visitors about the types of sounds that will be encountered in the park through interpretation and outreach prior to their arrival.

Key Findings

Response rates (Page 8)

- Overall. 512 visitors completed a questionnaire, achieving a 5% confidence interval at the 95% confidence level. The response rate for on-site questionnaires was 93%. Of the 205 online surveys sent, 149 were completed, yielding a response rate of 73%. There was only one refusal to provide an email address.
- Lake Clark (LACL). 218 respondents, who were intercepted in either LACL or KATM, indicated that they visited LACL and are included in the findings of this report. This achieves a 7% confidence interval at the 95% confidence level.

Demographics (Page 10)

- Age. The average reported age of LACL visitors was 54.
- Gender. There were 55% male respondents and 44% female.
- Education. 38% of visitors reported attaining a graduate or professional degree and 29% a four-year college education.
- Income. The largest group of questionnaire participants indicated incomes of either $150,000 to $199,999 (26%) or $200,000 or more (22%).
- Race. Most respondents self-identified as white (88%).
- Location of origin. Most respondents reside in the United States (89%) and locations of residence were relatively evenly spread throughout the country.

Locations and Activities (Page 8)

- Sources of information. When asked to indicate the primary source for learning about the park prior to their visit, the largest group of visitors responded "other" (40%). The second largest group indicated a guide service (29%), and 11% selected the official park website. The majority of "other" responses specified either online sources other than the official park website or word of mouth.
- Day vs. overnight use. About half of the respondents spent one day in the park (53%), 42% spent between 2-7 days, and the remainder (5%) spent ten or more days. The majority of overnight use occurred in private business or cabins in the park (90%).
- Guided vs. unguided. Most respondents reported spending the majority of their time with a professional guide (83%).
- Destinations. Survey intercept locations in LACL were the most commonly reported destinations: Crescent Lake (32%), Silver Salmon Creek (24%), and Twin Lakes/Proenneke's Cabin (25%).
- Main activity. The most common *main* reasons for visiting the park were bear watching (37%) and fishing (31%). 10% selected photography and 9% selected other. When asked

to select all activities engaged in, bear watching (78%), fishing (50%) and photography (54%) emerge as the most common.

Indicators (Page 12)

- Salient indicators. The most salient indicators were the visitors' own proximity to bears and the amount of the day that wildlife was present. The largest group (39%) of all respondents selected their own proximity to bears as the most important indicator, and 16% of respondents selected amount of day that wildlife was present as the most important experience or condition. Both indicators moderately increase the quality of the visitor experience; on a 7-point Likert scale from "extremely decreased the quality of my experience" to "extremely increased the quality of my experience", they scored averages of 5.66 and 5.61 respectively.
- Other potential indicators. Few respondents selected the remaining 18 indicators as the most important, however some conditions were shown to slightly improve the quality of the visitor experience while others had neutral or slightly negative effects. *See pages 11-15 for more results*.
- Fishing indicators. The most important fishing-related indicators were the condition of plants and vegetation surrounding fishing locations and number of other anglers encountered in one day. However, these indicators were not extremely salient. Respondents were neither satisfied nor dissatisfied with their catch and catch-related conditions were slightly under their expectations.

Soundscape preferences (Page 20)

Results are reported on a 9-point Likert scale from, "strongly disagree" to "strongly agree". A score of 5 represents the midpoint.

- Overall. On average and overall, visitors are satisfied with the current soundscape.
- Need to restore. The average response to whether the park's soundscape needs to be restored closer to natural conditions was neutral (4.75).
- Need to preserve/protect. Visitors agreed that the park's natural soundscape needs to be preserved/protected (6.34).
- Amount of noise. On average, visitors disagreed that there were too many non-natural or motorized noises (3.49) and that the human-caused noises they heard were inappropriate (3.49).
- Solitude. On average, visitors disagreed that the amount of time they heard motorized noise interfered with their sense of solitude (3.87), that the noise level of motorized noise interfered with their sense of solitude (3.94) and that the number of times they heard motorized noise interfered with their sense of solitude (3.84).
- Expectations. In response to the condition "I was knowledgeable about the types of sounds I would hear at the park prior to my visit", the visitor response was neutral on average (5.02). Visitors disagreed that there was more human-caused noise than they expected (3.29).

Table of Contents

Executive Summary	i
Key Recommendations	ii
Key Findings	iii
Introduction	1
Rationale	1
Objectives	2
Methods	3
Quantitative Questionnaires	3
Sampling Design and Locations	3
Results	8
Locations and Activities	8
Demographics	10
Indicators of Quality	12
Results	*12*
Open-Ended Questions	*17*
Fishing Indicators	*18*
Soundscape Preferences	20
Implications for Management	23

Table of Figures

Figure 1: Location of LACL in Alaska	1
Figure 2: Sampling locations in LACL	4
Table 1: Researcher days in each location	*5*
Figure 3: Time spent in park and percent guided visitors	8
Table 2. Visitor activities	9
Table 3. Visitor destinations	*10*
Figure 4: Zip code map of Alaska	11
Figure 5: Zip code map of the contiguous United States	11
Figure 6: Indicators of quality plotted level of influence and importance	13
Table 4: Salient indicators	*14*
Table 5: Group A indicators	*14*
Table 6: Group B indicators	*14*
Table 7: Group C indicators	*14*
Figure 7: Reported increases and decreases in visitor experiences	16
Table 8: Responses to "What did you enjoy most about your time in the park?	*17*
Table 9: Responses to "What did you enjoy least about your time in the park?	*18*
Table 10: Fishing-related indicators	*19*
Table 11: Levels of satisfaction with fish catch	*19*
Table 12: Fish catch conditions relative to expectations	*19*
Table 13: Perceptions of soundscapes	*21*
Figure 8: Perceptions of soundscapes	22

Introduction

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, 2017). This protection-visitor use dual mandate is applicable to all NPS units, including Lake Clark National Park and Preserve (LACL) (Figure 1). LACL features natural, cultural, and recreational resources that invite a population of visitors to its backcountry.

Established in 1980 as a national monument, and later enlarged and made a national park through the Alaska National Interest Lands Conservation Act, LACL boasts over 4 million acres of rivers, volcanoes, mountains, and landmarks. Lake Clark was established to protect its geological and ecological processes, creating scenic landscapes and pristine watersheds, which support fish, wildlife, and were vital to human history (National Park Service, n.d.).

Figure 1. *Location of LACL in Alaska*

Rationale

Visitation in the park has posed increasing management concerns at LACL, and park managers are challenged to develop effective and efficient management strategies for addressing important visitor use and impact issues.

Public land management occurs in a complicated environment that bridges social and environmental factors (Manning, 2011). While scientists and managers usually make decisions based on scientific evidence, wilderness visitors and managers may have diverging subjective evaluations of wilderness quality (Shin & Jackson, 1997; Manning, 2011). 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 & Paradice, 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 is to quantify relationships between visitor use, and resource and social conditions at LACL. This baseline information about park visitors can inform visitor use management and associated planning at LACL with the development and implementation of management plans at LACL.

Two phases were identified to inform the primary purpose of the research: 1) development of indicators to evaluate both social and natural resource attributes related to backcountry and wilderness management in general and the bear viewing experience specifically; 2) measuring thresholds for salient indicators and statistically verifying the preliminary indicators and thresholds, as well as collecting data to determine the relationships between patterns and ecological and social conditions in key locations. This preliminary report presents the results of Phase 1 and will be updated upon completion.

Methods

Quantitative Questionnaires

A quantitative visitor questionnaire (Appendix D) was distributed to backcountry day use and overnight visitors. Sampling for KATM occurred concurrently with sampling for an LACL study using the same survey instrument. Questionnaires included a question about which park was the visitor's primary destination and whether respondents visited both LACL and KATM. All those who indicated LACL as their primary destination or that they visited both parks were included in this report's analyses.

The survey instrument was developed with input from park management, and iterative discussions with park management were integrated throughout the survey-writing process, while a phone conversation with commercial use authorized operators elicited comments on a draft questionnaire, many of which were incorporated into the final instrument.

The questionnaire evaluated indicators of quality for visitors' experiences. Researchers also captured visitors' preferences regarding soundscapes, activities engaged in at LACL, information about sites visited and overnight use, and general demographics using standard U.S. Census Bureau categories. General demographics included zip code of primary residency, age, race, income, and education level. The survey uses best practices for survey construction, such as those set forth by Vaske (2008) and Dillman (2011). To gauge indicators of quality for visitors' experiences, the research team used an approach guided by the Interagency Visitor Use Management Framework (IVUMC, 2016).

In addition to on-site questionnaires, an online version of the questionnaire was solicited using a modified Dillman method (Dillman, 2011). Using this method, visitors were provided with a business card that included both a URL and QR code to access the questionnaire, as well as a unique access code with which researchers were able to track survey completion. Researchers collected an email address and correlated it with each card's access code, and two reminder emails were sent one week and two weeks following business card distribution. In all cases, each intercepted visitor who was 18 or over in age was asked to complete a survey on site or online. In field locations, researchers executed an entry briefing where they introduced themselves and the research upon the visitors' arrival, when possible. Then, researchers either distributed cards or identified an appropriate time and location for on-site questionnaire distribution and completion.

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 Clemson University approved the research methods after review from each Institutions' Internal Review Board (IRB).

Sampling Design and Locations

Questionnaires were distributed at nine intercept points, including regional travel corridors, sites in Katmai National Park and Preserve (KATM), and sites in Lake Clark National Park & Preserve (LACL). Due to the concurrent nature of sampling at LACL and KATM, visitors who visited any backcountry area in at least one of these parks were asked to complete a

questionnaire regardless of the intercept location. As some respondents visited both parks, KATM intercepts are included in the sampling design for this study, but questionnaire items allowed us to identify LACL visitors regardless of their intercept location.

To ensure a representative sample while attaining a sufficient sample size, researchers used a stratified random sampling procedure (Vaske, 2008) and distributed surveys at relatively high-use locations across the LACL backcountry and wilderness, as well as in regional travel corridors, according to peak use times identified by informal interviews with park staff and visitor resources provided on the park website (NPS, 2018). The sites are: Homer Airport (Homer, AK), Islands & Oceans Visitor Center (Homer, AK), King Salmon Airport (King Salmon, AK), Hallo Bay (KATM), Brooks Camp (KATM), Valley of Ten Thousand Smokes bus (KATM), Upper Twin Lakes/Proenneke Cabin (LACL), Crescent Lake (LACL), and Silver Salmon Creek (LACL). The field season ran from June 25 through August 3, while KATM staff continued to solicit surveys from visitors on the Valley of Ten Thousand Smokes bus beginning July 14 through the end of the summer. Because weather commonly impacts flight schedules, planned surveyor locations were adjusted frequently throughout the season, resulting the schedule reported in Table 1.

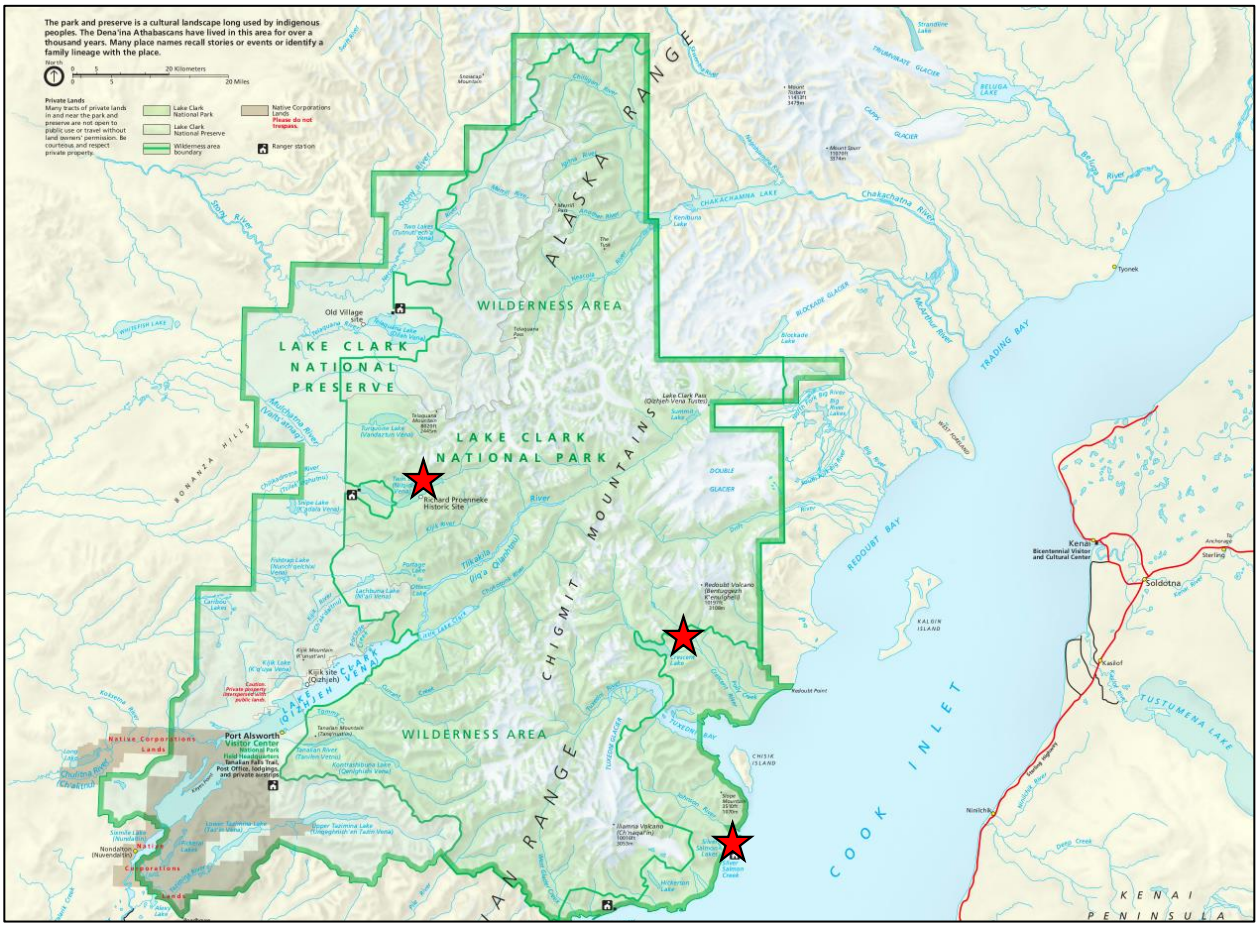


Figure 2. *Sampling locations in LACL*

.

Table 1. *Researcher days in each location. Numbers indicate the number of Kansas State University and Clemson University surveyors, while NPS refers to park staff distribution*

	Homer Airport	**I&O Visitor Center**	**King Salmon Airport**	**Hallo Bay**	**Brooks Camp**	**Valley of 10,000 Smokes**	**Upper Twin Lakes**	**Crescent Lake**	**Silver Salmon Creek**
6/25/18	2								
6/26/18	2								
6/27/18		2							
6/28/18	1	1							
6/29/18		2							
6/30/18		2							
7/1/18				3					
7/2/18				3					
7/3/18				3					
7/4/18				3					
7/5/18				3					
7/6/18				3					
7/7/18				3					
7/8/18				3					
7/9/18				3					
7/10/18				3					
7/11/18			1		1				
7/12/18			1		1				
7/13/18			1		1				
7/14/18			1			NPS			
7/15/18			1			NPS	1		
7/16/18			1			NPS	1		
7/17/18			1			NPS	1		
7/18/18			1			NPS	1		
7/19/18			1			NPS	1		
7/20/18			1			NPS	1		
7/21/18						NPS			
7/22/18						NPS		1	1
7/23/18						NPS		1	1
7/24/18						NPS		1	1
7/25/18						NPS		1	1
7/26/18						NPS		1	1
7/27/18						NPS		1	1
7/28/18						NPS		1	1
7/29/18						NPS		1	1
7/30/18			1			NPS			1
7/31/18			1			NPS			1
8/1/18			1			NPS			1
8/2/18			1			NPS			
8/3/18			1			NPS			
Total days	*3*	*4*	*15*	*10*	*3*		*6*	*8*	*11*
Total surveyor days	**5**	**7**	**15**	**30**	**3**	**N/A**	**6**	**8**	**11**

In LACL, researchers were on site at three locations. In Upper Twin Lakes/Prennoeke's Cabin, one researcher was present for 6 days. The researcher distributed surveys at the cabin site, where NPS rangers provide a guided tour. When visitors arrived at the cabin, the ranger met them on the beach where planes land or boats dock, during which time the researcher briefed the visitors about the study. After the visitors completed their activities at the site, they returned to their planes to depart and the researcher distributed surveys. Additionally, the NPS rangers monitor a campsite about half a mile away from the cabin. When visitors were present at the campsite, the researcher intercepted them there.

One researcher was present at Silver Salmon Creek for 11 days. There are two main beach areas where visitors arrive in Silver Salmon Creek, bisected by a creek. Day use visitors arrive on one of these beaches and recreate throughout the area. The ability for planes to land and take off on these beaches is also tidally influenced, leading to a restricted spatiotemporal window of visitor activity. Additionally, the bisecting creek is tidally influenced, which restricts the ability for researchers to cross during certain times. The length of the beach and the limited window during which planes arrive and leave, make intercepts on foot challenging, so when possible, the researcher joined an NPS ranger during ATV roving patrol. When not possible, the researcher remained in an area of the beach where planes land most often. Additionally, two lodges operate in Silver Salmon Creek, serving overnight visitors who engage in activities such as bear viewing and fishing. By request of the lodge owners, these visitors were intercepted on the premises of one of the lodges. Intercepts mainly occurred during an indoor pre-dinner social hour and occasionally in common areas between cabins.

One researcher was present in Crescent Lake for 8 days. There is one beach location where visitors primarily arrive via aircraft and move throughout Crescent Lake on fishing vessels. The visitor groups generally arrive on the beach location, spend a notable amount of time fishing downriver from the beach location and conclude their trip by returning to the beach location to depart Crescent Lake. The researcher distributed surveys to visitors during the time period at the end of their trip that involved their return to the beach location and their departure. Additionally, the researcher intercepted visitors at a lodge on site during meal times.

In KATM, researchers were on site at two locations: Brooks Camp and Hallo Bay. At Brooks Camp, visitors were intercepted opportunistically at the picnic area, on platforms, and on trails. These visitors were thoroughly screened, and only those who had visited other parts of KATM or LACL, including overnight stays in the Valley of Ten Thousand Smokes, were offered a questionnaire.

In Hallo Bay, researchers intercepted visitors primarily on the north beach. The shore of Hallo Bay is primarily oriented north-south and is bisected by Middle Creek. Visitors rarely cross from one side of the creek to the other, particularly because it is tidally influenced and difficult to cross during high tides. Day-use visitors typically land on the beach, engage in a bear safety orientation, and then proceed to another part of Hallo Bay. Visitors also resided overnight on boats docked off shore, coming to land for scattered periods of time throughout the day. Depending on the preferences of guides or other logistical considerations, visitors were generally intercepted in one of two ways. Most commonly, visitors were intercepted upon arrival or departure and solicited for an online questionnaire (we gave them a business card with a URL, and they gave us an email address). Some overnight visitors were approached upon arrival and provided an entry briefing where researchers introduced the study, then solicited with paper questionnaires upon departure.

Homer and King Salmon Airport intercepts occurred in the terminal/gate area of each airport. The airports are small, and researchers were able to monitor the entire waiting area and approach most flyers. Travelers were thoroughly screened to assess whether: (a) they visited either KATM or LACL and (b) they visited some place other than Brooks Camp, i.e. a backcountry area. Visitor intercepts at the Islands & Oceans Visitor Center employed the same screening process and occurred in the main lobby area of the building.

During regional travel corridor intercepts, researchers approached travelers at random and asked a series of qualifying questions to determine whether the person visited LACL:

2) Have you visited either KATM or LACL within the last 30 days?
    a. If no → are you planning to visit either destination during your visit?
    b. If yes → did you (or are you planning to) visit an area other than Brooks Camp?

The question regarding Brooks Camp was often used because Brooks Camp is the only area of either KATM or LACL, which were being studied concurrently, not included in the study. Brooks Camp was typically a name that participants recognized and was a useful and straightforward way to identify individuals who had visited backcountry areas.

In some cases, these qualifying questions were clear to respondents. Other times, people could not answer these questions either because they did not know the names of the locations they visited, or they could not remember (*See results regarding locations and activities for more*). In these cases, researchers would attempt to identify whether the individual visited an area in either LACL or KATM by asking alternative questions regarding the place they visited, activities they engaged in, or infrastructure present. For example, researchers may have asked whether the place had bear viewing platforms and a visitor center, which are only present in Brooks Camp.

Those visitors that had visited either or both parks in the past 30 days were asked to complete the questionnaire, while those who were planning to be were offered a business card and asked to provide an email address for online completion.

Results

During sampling, 512 visitors completed a questionnaire, achieving a 5% confidence interval at the 95% confidence level. The response rate for on-site questionnaires was 93%. Of the 205 online surveys sent, 149 were completed, yielding a response rate of 79%. There was only one refusal to provide an email address.

This completion amount represents individual visitors (every person in the group was asked to complete a questionnaire). 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 Katmai National Park and Preserve (KATM) and Lake Clark National Park and Preserve (LACL).

Of the 512 respondents, 199 selected LACL as their primary destination, and another 19 selected KATM but indicated that they visited both parks (55 total respondents visited both parks). Therefore, 218 respondents visited LACL. This achieves a 7% confidence interval at the 95% confidence level.

Locations and Activities

Of the 211 respondents who reported the number of days spent in the park, 53% were single-day users. Forty-two percent of visitors spent between 2-7 days, and 5% respondents spent ten or more days in the park. The majority of reported overnight use occurred with private business or cabins in the park (90%), 7% of visitors reported camping in the park, and 3% reported staying outside of the park. Eighty-three percent of visitors reported to be accompanied by a professional or commercial guide during most of their time in the park.

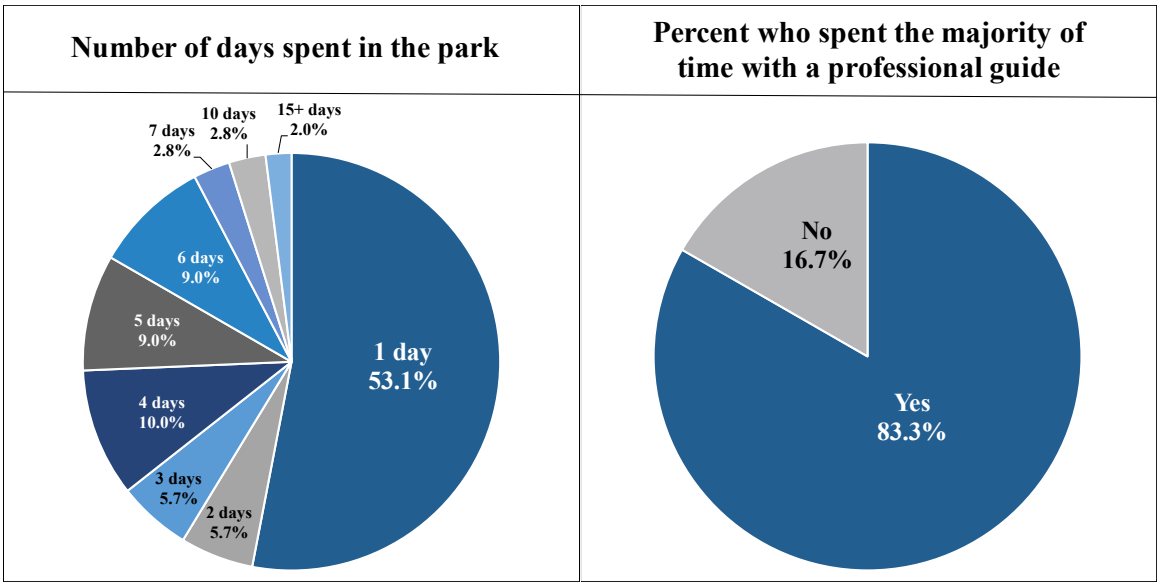


Figure 3. *Time spent in park and percent guided visitors*

When asked to indicate their primary source for learning about the park prior to the visit, the largest group (40%) of visitors selected "other." The second largest group (29%) indicated a guide service, 11% selected the official park website, and the remainder were split between the explore.org bear cameras, social media, television or film, travel agency, and YouTube.

Of the 65 visitors who selected "other," 32% specified internet sources other than the official park website, and 31% specified word of mouth or specific people. 10% of those who selected other indicated that they knew about the area because they are local or AK residents, and the remaining responses include sources such as books, businesses, or photography resources.

The most common main reasons for visiting the park were bear watching (37%) and fishing (31%). 10% selected photography and 9% selected other. Visitors were also asked to select all activities engaged in (Table 2).

Table 2. *Visitor activities*

Activity	**Percent of Sample**	
	Select all activities participated in	***Main reason***
Bear Watching	**78.0**	**36.8**
Fishing	**50.0**	**31.8**
Photography	**54.1**	10.4
Flightseeing	35.8	4.5
Part of Organized Tour	14.7	3.5
Backcountry Camping	5.0	2.5
Backcountry Hiking	19.3	1.5
Boating	28.0	0.0
Hunting & Trapping	0.5 (1 respondent)	0.0
Other	4.6	8.5

Respondents were also asked to report which locations they visited (Table 3). Unsurprisingly, the survey intercept locations in LACL were most commonly reported (Silver Salmon Creek, Twin Lakes, and Crescent Lake). 12% did not know the location names of the places they visited.

Table 3. *Visitor destinations*

Location	Percent of Sample
American Creek (KATM)	0.0
Chinitna Bay (LACL)	8.7
Crescent Lake (LACL)	32.6*
Geographic Harbor/Amalik Bay (KATM)	0.0
Hallo Bay (KATM)	0.5*
Kukak Bay (KATM)	1.4
Kukaklek Outlet (KATM)	0.9
Kulik River (KATM)	2.3
Moraine Creek/Funnel Creek (KATM)	2.3
Silver Salmon Creek (LACL)	24.8*
Twin Lakes/Proenekke's Cabin (LACL)	25.7*
Other	10.6
I did not visit any of these areas	2.8
I do not know the locations names of the places I visited	11.5

**Survey intercept locations*

Overall Demographics of Visitors

The average age of respondents was 54, and the median age was 57. There were slightly more male visitors, with 56% respondents identifying as male, 44% identifying as female. Thirty-nine percent of visitors reported attaining a graduate or professional degree, 30% four-year college graduate, 7% two-year college graduate, 15% some college, 7.6% high school graduate (2% indicated that they do not wish to answer). Most participants indicated a household income of either $150,000 to $199,999 (26%) or $200,000 or more (23%). Most respondents (88%) self-identified as white, while 6% self-identified as Asian, 1% self-identified as Hispanic or Latino/Latina, 4% declined to answer, and the remainder of participants self-identified as other races. Respondents primarily originated from the United States, with a relatively even spread throughout the contiguous U.S. (Figures 4 and 5). Eighteen percent of visitors originated from Alaska. International visitors comprised 11% of the sample (23 respondents), and were from Australia, Canada, Chile, Denmark, Israel, New Zealand, Scotland, South Africa, and the United Kingdom.

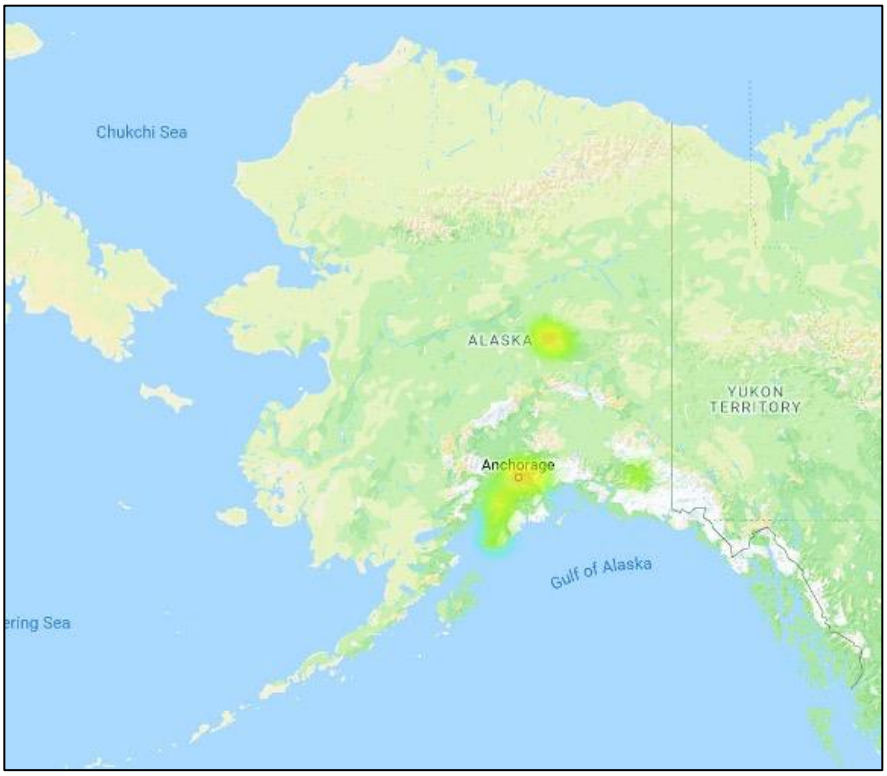


Figure 4. *Zip code map of Alaska.*

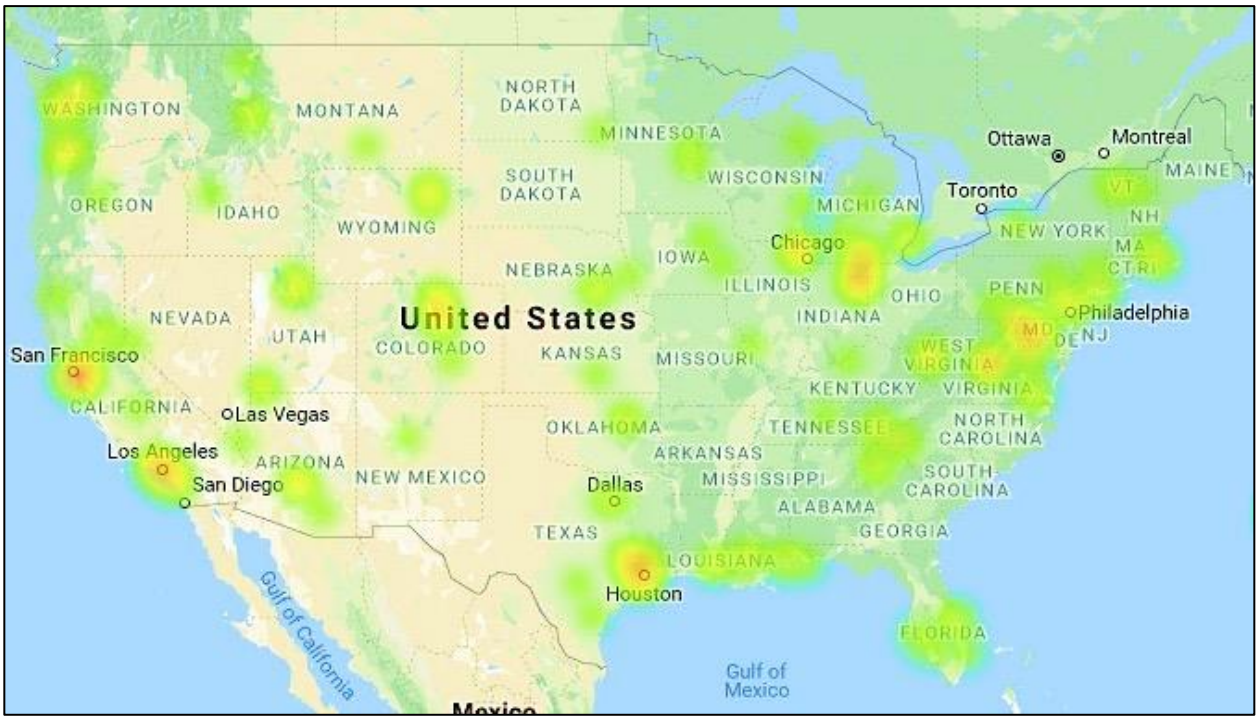


Figure 5. *Zip code map of the contiguous United States.*

Indicators of Quality

Visitors were asked to assess 20 experiences and conditions for the level at which they increased or decreased the quality of their experience. Additionally, respondents were asked to select the most important experience or condition that influenced the quality of their experience.

Because there are statistical differences between responses from visitors who indicated KATM and LACL as primary destinations, responses to questions regarding indicators of quality are reported from the sample of 218 respondents who indicated that they visited LACL.

Independent t-tests were conducted to evaluate whether visitors who indicated each park as their primary destination had statistically significant differences in their responses to the first set of questions, which asked respondents to indicate the level at which each condition increased or decreased the quality of their experience (Appendix B). Of the 20 potential indicators included in the questionnaire, seven were statistically different between groups at the 0.05 level.

To determine whether there is a significant different between the groups' responses when asked to select the most important indicator, a Pearson Chi-squared analysis was conducted. The Chi-squared value is .006, which could indicate that there is a significant association between respondents' primary destination and the condition they selected as the most important. However, because most of the potential indicators were selected by very few respondents, the test may not be a reliable indicator of statistical differences (Appendix B).

Results

Figure 6 plots all 20 indicators according to these two dimensions. The x-axis displays the mean value across all respondents on a 7-point Likert scale, where 1 represents a condition that extremely decreased the quality of the visitors' experience, and 7 extremely increased the quality of their experience. Selecting "4" indicated that the condition neither decreased nor increased the quality of their experience.

The two most salient indicators combined were selected by 55% of respondents as the most important experience or condition that influenced the quality of their experience (Table 4). The remaining respondents identified one of the remaining 18 experiences as the most important experience or condition that influenced the quality of their experience.

While very few respondents selected conditions other than the two salient indicators as their most important experience or conditions, it is useful to understand to what degree each condition increases or decreases the quality of visitor experiences. The number of cases outside the three salient indicators were too small to conduct a reliable cluster analysis, however two groups appear to emerge (Figure 6).

The most salient indicators (Table 4) were the visitors' own proximity to bears and the amount of the day that wildlife was present. They influenced the quality of visitors' experiences similarly; visitors indicated that these experiences and conditions moderately to extremely increased the quality of their experience. Nearly half (47%) of all respondents selected their own proximity to bears as the most important indicator, and 17% of respondents selected amount of day that

wildlife was present as the most important experience or condition. Both of these conditions moderately increased the quality of the visitor experience.

Conditions in Group A (Table 5) slightly increase the quality of visitors' experiences and have low levels of importance overall. Conditions in Group B (Table 6) are reported to have a neutral or slightly positive influence on visitors' experiences and a low level of importance. Conditions in Group C (Table 7) slightly decrease the quality of visitors' experiences and have a very low level of importance overall.

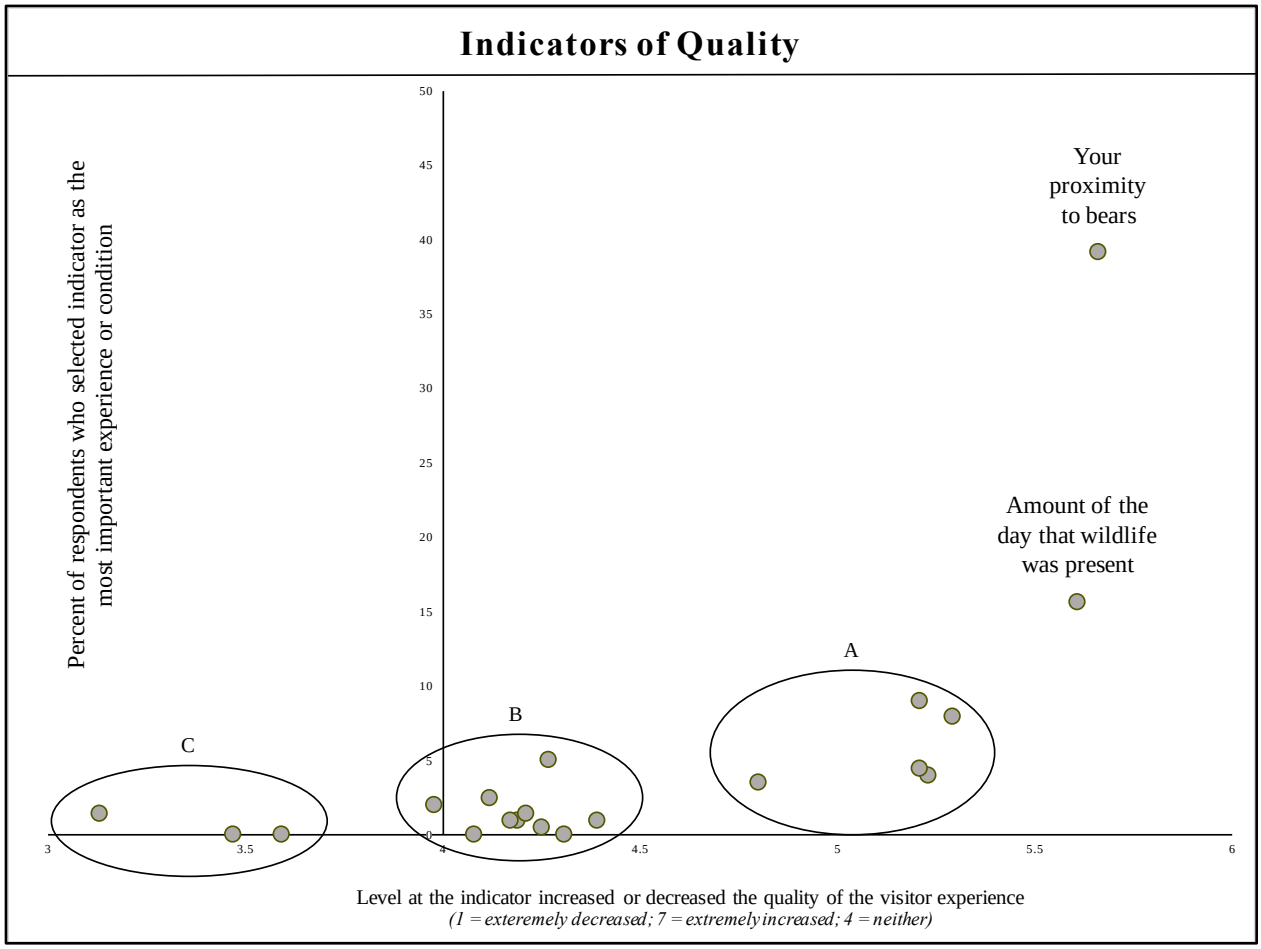


Figure 6. *Indicators of quality plotted level of influence and importance*

Table 4. *Salient indicators*

Salient indicators		
Indicator	***Mean influence****	***% most important (frequency)***
Your proximity to bears	5.66	39.2 (78)
Amount of the day that wildlife was present	5.61	15.6 (31)

Table 5. *Group A indicators*

Group A		
Indicator	***Mean influence****	***% most important (frequency)***
Amount of time without human produced noise	5.29	8.0 (16)
Amount of time without hearing other visitors	5.23	4.0 (8)
Interacting with a park ranger	5.21	9.0 (18)
Amount of time without seeing other visitors	5.21	4.5 (9)
Behavior of other guides	4.80	3.5 (7)

Table 6. *Group B indicators*

Group B		
Indicator	***Mean influence****	***% most important (frequency)***
# of planes landing or taking off close to me	3.98	2.0 (4)
Other visitors' proximity to bears	4.08	0.0 (0)
# of other people viewing a bear	4.12	2.5 (5)
# of planes parked at one location	4.17	1.0 (2)
Amount of litter seen	4.19	1.0 (2)
# of planes heard in one day	4.21	1.5 (3)
# of planes seen in one day	4.25	0.5 (1)
# of other people encountered in one day	4.27	5.0 (10)
Amount of time other visitors are heard	4.31	0.0 (0)
Amount of time other visitors are seen	4.39	1.0 (2)

Table 7. *Group C indicators*

Group C		
Indicator	***Mean influence****	***% most important (frequency)***
# of campsites within sight of me	3.59	0.0 (0)
Amount of sound from other campsites around me	3.47	0.0 (0)
# of visitors breaking wildlife viewing rules	3.13	1.5 (3)

**Measured on a 7-point scale, ranging from extremely decreased (1) to extremely increased (7) the quality if their experience. A response of 4 indicates that the condition neither increased nor decreased the quality of their experience*

Figure 7 shows all 20 conditions and experiences that visitors were asked to assess on a 7-point Likert scale, from “extremely decreased the quality of my experience” (coded as 1) to “extremely decreased the quality of my experience” (coded as 7) across both KATM and LACL. A response of 4, displayed as grey in the figure, indicates that it neither increased nor decreased the visitors’ quality of experience. Next to each condition is a mean value and standard deviation; this is the mean across all valid responses. This does not include visitors who selected “did not experience,” and the percent of visitors who selected that option is displayed in the right-most column. The remaining percentages in the figure represent the proportion of visitors who selected each response *out of the respondents who selected a 1-7 response*.

From left to right, the colors represent percent responses on the 1-7-point scale. The position of the grey bar (respondents who indicated that the condition neither increased nor decreased the quality of the experience) displays the difference in the number of respondents who indicated that the experience was positive or negative; if the bar is to the left of center more visitors found the experience to be positive, and if it is right of center more visitors found the experience to be negative. This is different than a mean, because it does not weight for the degree to which the respondents’ quality of experience was influenced. This is displayed in the color tone for each bar; more dark tones display more extreme increases or decreases.

For example, the means for number of planes parked in one location (AAOT) and amount of litter seen are very similar and close to neutral. However, from the placement of the grey bar it can be understood that more visitors thought AAOT positively impacted the quality of their experience relative to those who thought it negatively impacted their experience, but more respondents were neutral and a large number of the those who believed it increased the quality of their experience only believed it was a slight increase. In contrast, responses to the amount of litter were more evenly spread between positive and negative responses.

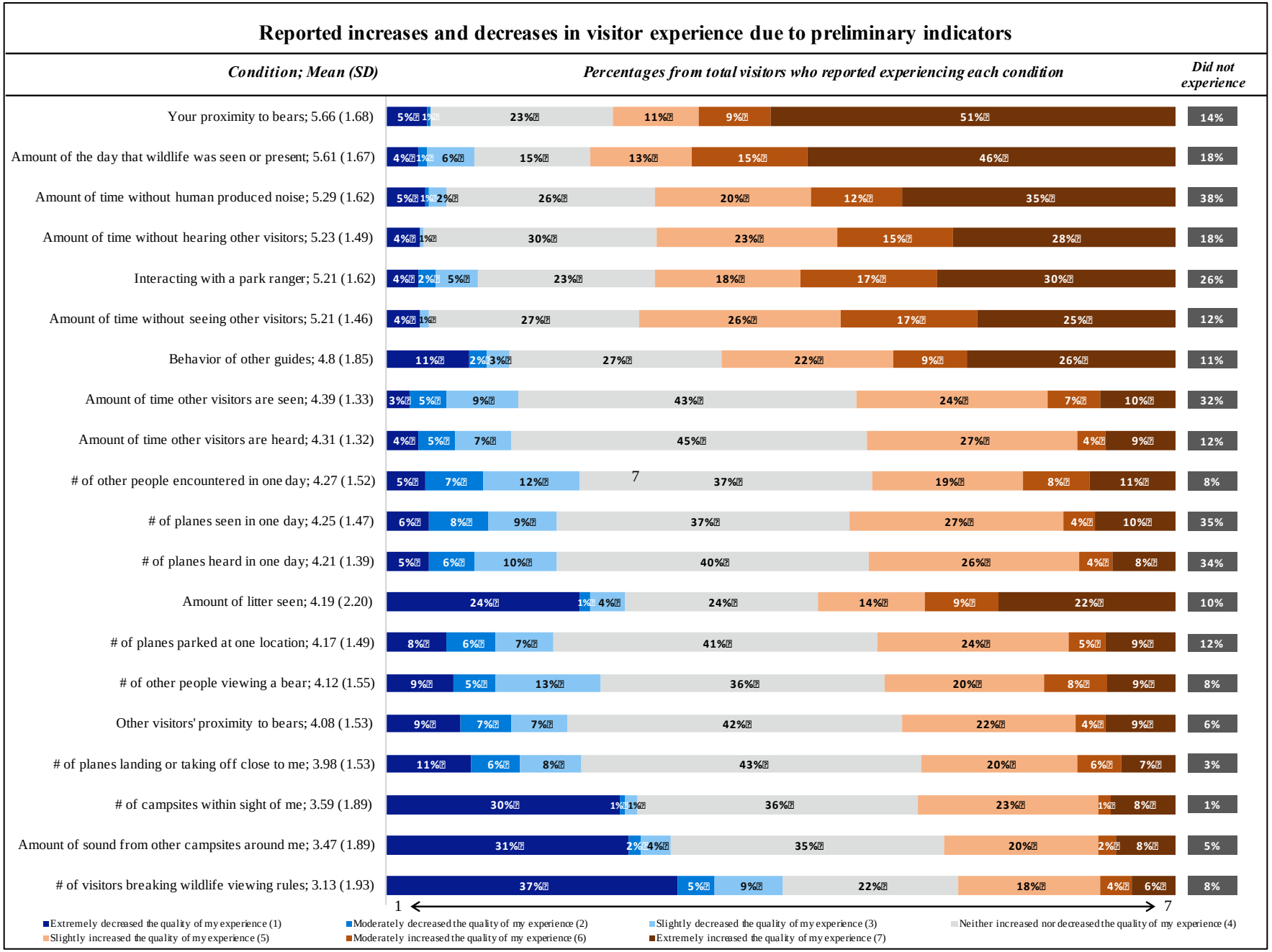


Figure 7. *Distribution of responses to each indicator on a 7-point Likert scale from, extremely increased to extremely decreased the quality of the visitors' experience*

Open-Ended Questions

The questionnaire also included two open ended questions: "What did you enjoy most about your time in the park?" and "What did you enjoy least about your time in the park?". Responses to the both questions were manually coded. When respondents described multiple elements of their experience, the response was coded according to the first condition mentioned (Tables 8 and 9).

For responses to the first question, regarding the visitors' most enjoyable experience, categories were distance to bear (DTB), presence of wildlife (POW), environment, bear viewing, fishing, or other. Responses coded as DTB involved nearness to bears. POW included responses that directly involved the density of wildlife or amount of wildlife seen, as well as responses that simply stated a wildlife species, such as bears or fish. Responses coded as environment include descriptions of natural beauty, landscapes generally, solitude, or quietness. Bear viewing responses directly reference watching or viewing bears, and fishing responses directly reference sport fishing. Responses coded as other include references to activities other than fishing or bear viewing, infrastructure, people or groups of people, and more.

Of the 216 respondents who replied to the first question, regarding their most enjoyable experience, 42% indicated environment, 16% indicated bear viewing, 13% indicated POW, 13% indicated fishing, 3% indicated distance to bears, and 14% indicated other conditions, such as hiking activities or lodge staff. Of the 90 respondents that indicated environment, 13% (12 respondents) mentioned conditions related to solitude and 11% (10 respondents) mentioned elements related to quietness or remoteness. These results align with quantitative data elicited in response to potential indicators, described in the previous section of this report, and indicate that questionnaire responses are internally consistent.

In response to the question about their least enjoyable experience, 13% of survey respondents did not write anything and 31% of respondents indicated that the question was not applicable or that there was nothing they did not enjoy. Responses were categorized as follows: weather and insects (22%); motorized traffic (8%), which included responses related to density of planes or presence of ATVs; monetary costs or insufficient time in the park (6%); crowding of people (6%); perceived conflict between guides, staff, and visitors, including stated displeasure with rule enforcement even if expressed conflict did not arise (5%). The remaining responses (10%) are considered "other," and they include a wide variety of conditions regarding bear safety concerns, availability of trails, waking distances, and more.

Table 8. *Responses to question, "What did you enjoy most about your time in the park?"*

Category	**Percent of Sample (Frequency)**
Environment	41.7 (90)
Bear viewing	16.2 (35)
Presence of wildlife	12.5 (27)
Fishing	12.5 (27)
Distance to bears	3.2 (7)
Other	13.9 (0)

Table 9. *Responses to question, "What did you enjoy least about your time in the park?"*

Category	**Percent of Sample (Frequency)**
Nothing	31.2 (68)
Weather and insects	22.0 (48)
Motorized traffic	8.3 (18)
Costs and time	6.0 (13)
Crowding	5.5 (12)
Perceived conflict	4.6 (10)
Blank response	12.8 (28)
Other	9.6 (21)

Fishing Indicators

In addition to the indicators for general visitor experience, visitors who fished were asked to respond to 13 experiences and conditions. While some respondents skipped questions, between 96 and 98 respondents indicated whether and to what degree each condition increased or decreased the quality of their experience. On a 7-point Likert scale, where 1 represents a condition that extremely decreased the quality of the visitor's experience and 2 represents a condition that extremely increased the quality of the visitor's experience, mean values for all 13 potential indicators were between 3.00 and 5.45 (Table 10). Respondents who fished were also asked to select the most important fishing-related condition that influenced the quality of their fishing; 81 respondents selected a condition.

Additionally, if visitors reported fishing, they were asked to answer questions related to catch. The mean number of fish respondents reported catching was 8.06 (standard deviation: 12.69). On a 5-point scale from extremely dissatisfied to extremely satisfied (3 = neither satisfied nor dissatisfied), responses regarding catch type, frequency, and quality were close to neutral (Table 11). Finally, respondents who fished were asked how four catch-related conditions aligned with their expectations on a 5-point scale from significantly less than expected to significantly more than expected (3 = neither less or more than expected). Mean responses were slightly less than neutral (Table 12).

Table 10. *Fishing-related indicators*

Fishing-Related Indicator	Mean (SD) influence *	% most important (Frequency)
Condition of plants and vegetation surrounding your fishing location(s)	5.45 (1.85)	13.6 (11)
# of other anglers that you encounter during a single day of fishing	4.13 (1.74)	13.6 (11)
# of bear encounters that you experienced during one day that interfered with your angling efforts	4.14 (1.99)	12.3 (10)
Amount of time you waited to access a desirable fishing location due to the presence of other anglers	3.69 (2.12)	9.9 (8)
# of other planes visible while fishing	3.94 (1.68)	9.9 (8)
Proximity of other anglers to you during active fishing time	4.20 (1.78)	9.9 (8)
# of fish you caught with visible scarring from previous catches	3.38 (1.73)	7.4 (6)
Amount of time other anglers were visible to you	4.86 (1.9)	6.2 (5)
# of other boats visible while fishing	4.29 (1.37)	6.2 (5)
Condition of trails surrounding your fishing location(s)	4.38 (1.8)	4.9 (4)
# of times in one day you were not able to access a desirable fishing location due to the presence of other anglers	3.19 (2.14)	3.7 (3)
Amount of angling related litter seen in one day (e.g. discarded fishing line)	3.00 (1.97)	2.5 (2)
# of times in one day you were not able to access a desirable fishing location due to the presence of other visitors who were not fishing	3.07 (2.11)	0.0 (0)

Table 11. *Levels of satisfaction with fish catch*

Condition	Mean (SD) satisfaction*
Species or type of fish I caught	4.40 (0.774)
Size of the fish I caught	4.34 (0.819)
Number of fish caught	4.30 (0.93)
Frequency of catching fish	4.22 (0.943)
Number of fish seen with visible scarring/damage from catch and release	3.70 (1.017)

Table 12. *Fish catch conditions relative to expectations*

Condition	Mean (SD) expectation*
Size of fish I caught	3.54 (0.807)
Species or type of fish I caught	3.41 (0.815)
Frequency of catching fish	3.38 (0.932)
Number of fish caught	3.35 (0.906)

**Measured on a 7-point scale, ranging from extremely decreased (1) to extremely increased (7) the quality if their experience. A response of 4 indicates that the condition neither increased nor decreased the quality of their experience.*

Soundscape Preferences

Because responses to questions regarding soundscape preferences were statistically different between respondents who selected either LACL or KATM as their primary destination (Appendix D), results in this section include only respondents who reported visiting LACL.

Respondents indicated their agreement with statements regarding soundscapes on a 9-point Likert scale from, strongly agree to strongly disagree. On average and overall, visitors are satisfied with the current soundscape. The average response to whether the park's soundscape needs to be restored closer to natural conditions was neutral (4.75), and visitors agreed that the natural soundscape needs to be preserved/protected (6.34).

Visitors disagreed that there were too many non-natural or motorized noises (3.49) and that the human-caused noises they heard were inappropriate (3.49). On average, visitors slightly disagreed that the amount of time they heard motorized noise interfered with their sense of solitude (3.87), that the noise level of motorized noise interfered with their sense of solitude (3.94), and that the number of times they heard motorized noise interfered with their sense of solitude (3.84). In response to the condition "I was knowledgeable about the types of sounds I would hear at the park prior to my visit", the visitor response was neutral on average (5.02). Visitors disagreed that there was more human-cause noise than they expected (3.29).

Figure 8 and Table 13 display responses to all soundscape conditional statements on a 9-point Likert scale from, "strongly disagree" to "strongly agree." A response of 5, displayed as grey in the figure, indicates the midpoint, represents a neutral response.

Figure 8 should be interpreted similarly to Figure 7. Next to each condition is a mean value and standard deviation; this is the mean across all valid responses. From left to right, the colors represent percent responses on the 1-9 scale. The position of the grey bar (respondents who selected the midpoint on the 9-point scale) displays the difference in the number of respondents who indicated that the experience was positive or negative; if the bar is to the left of center more visitors found the experience to be positive, and if it is right of center more visitors found the experience to be negative. This is different than a mean, because it does not weight for the degree to which the respondent's quality of experience was influenced. This is displayed in the color tone for each bar; more dark tones display more extreme increases or decreases.

Table 13. *Percent of respondents who agree or disagree with statements about soundscapes in the park.*

	Mean; SD	**Strongly Disagree (1)**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Strongly Agree (9)**
The park's natural soundscape needs to be preserved/protected	*6.34; 2.61*	10.0%	3.5%	2.0 %	0.5 %	23.0 %	6.0%	14.5 %	8.0 %	32.5%
I was knowledgeable about the types of sounds I would hear at the park prior to my visit	*5.02; 2.47*	15.7%	4.5%	4.0 %	6.6 %	33.3 %	9.1%	10.1 %	3.0 %	13.6%
The noise level of motorized sounds I heard interfered with my sense of solitude	*3.94; 2.44*	27.9%	12.3 %	4.9 %	3.9 %	27.5 %	10.8 %	7.4%	1.0 %	4.4%
The amount of time I heard motorized noise interfered with my sense of solitude	*3.87; 2.37*	27.9%	12.3 %	4.9 %	3.9 %	27.5 %	10.8 %	7.4%	1.0 %	4.4%
The number of times I heard motorized noise interfered with my sense of solitude	*3.84; 2.38*	27.9%	12.3 %	4.9 %	3.9 %	27.5 %	10.8 %	7.4%	1.0 %	4.4%
The park's soundscape need to be restored closer to natural conditions	*3.84; 2.38*	15.3%	7.9%	5.4 %	4.9 %	38.4 %	6.4%	6.4%	1.0 %	4.4%
The park has too many non-natural or motorized noises	*3.49; 2.25*	31.8%	13.4 %	5.0 %	4.5 %	28.9 %	7.5%	5.0%	2.0 %	2.0%
The human-caused noise I heard are inappropriate sounds to hear while at the park	*3.49; 2.17*	27.9%	12.3 %	4.9 %	3.9 %	27.5 %	10.8 %	7.4%	1.0 %	4.4%
There were more human-caused noises than I expected at the park	*3.29; 2.11*	32.8%	13.1 %	9.1 %	3.5 %	31.8 %	1.5%	5.6%	1.5 %	1.0%

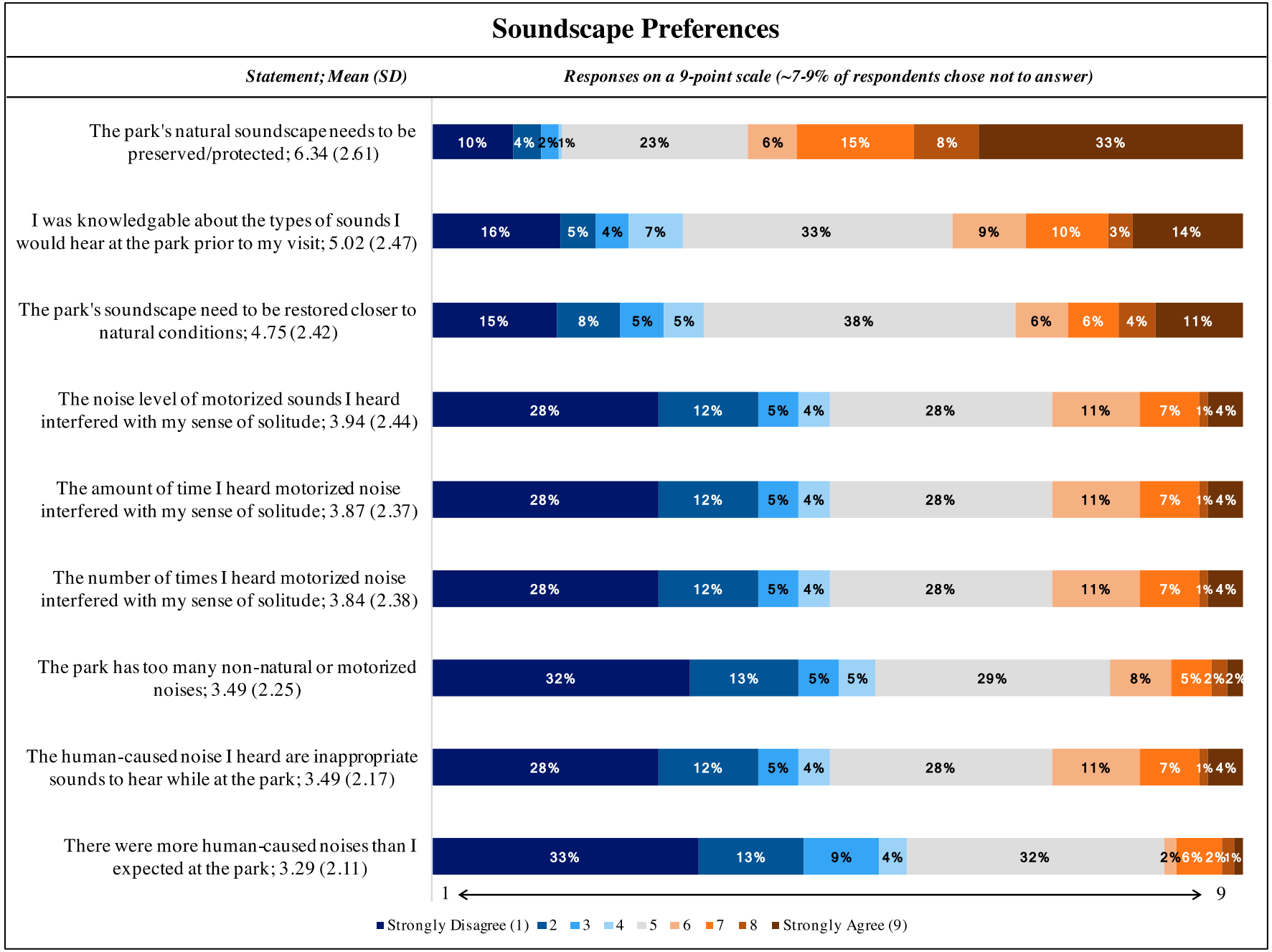


Figure 8. *Distribution of agreement to soundscape conditions on a 9-point Likert scale from, strongly agree strongly disagree.*

Implications for Management

Indicators of Quality

This report represents initial stages of visitor use management using an indicators and thresholds framework and is aligned with the Interagency Visitor Use Management Framework (IVUMC, 2016). According to the IVUMF, 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 (IVUMC, 2016). Development of indicators may guide iterative and adaptive management of visitors at Lake Clark National Park and Preserve, particularly if accompanying thresholds are established using an approach based on Normative theory.

Normative theory 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. 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).

Soundscape Preferences

Results regarding preferences regarding soundscapes reveal that while visitors are satisfied with the current soundscapes, they agree that the current conditions should be protected. As suggested in the key recommendations section of this report, continued monitoring of present soundscapes conditions aligns with reported visitor preferences. Additionally, LACL may consider continuing to limit increases in artificial sounds.

Appendix C: References and Appendices for Preliminary Research Reports 2017-2018

References

Anderson, L. E., Manning, R. E., Valliere, W. A., & Hallo, J. C. (2010). Normative standards for wildlife viewing in parks and protected areas. Human Dimensions of Wildlife, 15(1), 1-15.

Arnberger, A., Eder, R., Allex, B., Sterl, P., & Burns, R. C. (2012). Relationships between national-park affinity and attitudes towards protected area management of visitors to the Gesaeuse National Park, Austria. Forest Policy and Economics, 19, 48-55.

Borrie, W. T., Davenport, M., Freimund, W. A., & Manning, R. E. (2002). Assessing the relationship between desired experiences and support for management actions at Yellowstone National Park using multiple methods. journal of Park and Recreation Administration, 20(3), 51.

Dillman, D. A. (2011). Mail and Internet surveys: The tailored design method--2007 Update with new Internet, visual, and mixed-mode guide. John Wiley & Sons.

Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. Harcourt Brace Jovanovich College Publishers.

Hallo, J. C., & Manning, R. E. (2009). Understanding and managing the off-road vehicle experience: Standards of quality. Managing Leisure, 14(4), 269-285.

Inglis, G. J., Johnson, V. I., & Ponte, F. (1999). Crowding norms in marine settings: A case study of snorkeling on the Great Barrier Reef. Environmental Management, 24(3), 369-381.

Interagency Visitor Use Management Council. (2016). Visitor Use Management Framework: A Guide to Providing Sustainable Outdoor Recreation. Edition One.

Kyle, G., Graefe, A., Manning, R., & Bacon, J. (2004). Effects of place attachment on users' perceptions of social and environmental conditions in a natural setting. Journal of environmental psychology, 24(2), 213-225.

Loomis, D. K., Anderson, L. E., Hawkins, C., & Paterson, S. K. (2008). Understanding coral reef use: SCUBA diving in the Florida Keys by residents and non-residents during 2006-2007. HDMCE Analysis Series, 1-003.

McLaughlin, W. J., & Paradice, W. E. J. (1980, February). Using visitor preference information to guide dispersed winter recreation management for cross-country skiing and snowmobiling. In Proceedings of the North American symposium on dispersed winter recreation (pp. 64-72).

Monz, C. A., Cole, D. N., Leung, Y. F., & Marion, J. L. (2010). Sustaining visitor use in protected areas: future opportunities in recreation ecology research based on the USA experience. Environmental management, 45(3), 551-562.

Manning, R.E. (2011). Studies in outdoor recreation 3rd edition. Oregon State University Press

Manning, R., Leung, Y. F., & Budruk, M. (2005). Research to support management of visitor carrying capacity of Boston Harbor Islands. Northeastern Naturalist, 12(sp3), 201-220.

National Park Service (2018). Bear Watching. Retrieved from https://www.nps.gov/katm/planyourvisit/bear-watching.htm

National Park Service (n.d.). Lake Clark National Park & Preserve. Retrieved from www.nps.gov/lacl/index.htm

Shelby, B., Vaske, J. J., & Donnelly, M. P. (1996). Norms, standards, and natural resources. Leisure Sciences, 18(2), 103-123.

Shin, W. S., & Jackson, R. (1997). Wilderness quality and visitors' wilderness attitudes: Management implications. Environmental Management, 21(2), 225-232.

Vaske, J. J. (2008). Survey research and analysis: Applications in parks, recreation, and human dimensions. State College, PA: Venture.

Appendices

Appendix A: Quantitative Questionnaire

Katmai National Park & Preserve
Lake Clark National Park & Preserve
Visitor Survey

Indicators 2018

To be completed by field staff:

ID _____ Travel party ID_____ Tracker number _____ Date _____ Time_____

Location _____ Field staff_____ Approximate arrival time to site_____

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.

1. Please indicate your primary destination (check only one please):

❑ Lake Clark National Park and Preserve ❑ Katmai National Park and Preserve

2. Did you visit both parks? Yes / No (circle one)

3. Did you visit the park as a scheduled excursion from a cruise? Yes/No (circle one)

4. How many days did you spend in the park? _____

4a. If you spent more than one day in the park, what were your overnight accommodations: (please check all that apply)

❑ I camped in the park ❑ I stayed at Brooks lodge ❑ I stayed outside of the park
❑ I stayed a private business lodge/cabin in the park. Please specify the business_____

5. During most of your time in the park, were you accompanied by a professional/commercial guide?

❑ Yes ❑ No

6. Please indicate the primary source for learning about the park prior to your visit.

❑ Explore.org bear cameras
❑ Guide service
❑ Official park website
❑ Social media
❑ Television/film
❑ Travel agency
❑ YouTube videos
❑ Other:

7. What was your MAIN reason for visiting the park (check only one please)

❑ backcountry camping
❑ backcountry hiking
❑ bear watching
❑ boating
❑ fishing
❑ flightseeing
❑ hunting & trapping
❑ part of organized tour
❑ photography
❑ other, specify:

8. Please indicate ALL the activities you participated in during this visit to the park (check all that apply)

❑ backcountry camping
❑ backcountry hiking
❑ bear watching
❑ boating
❑ fishing
❑ flightseeing
❑ hunting & trapping
❑ part of organized tour
❑ photography
❑ other, specify:

9. Please indicate which of the following locations you visited. Please check all that apply.

❑ American Creek
❑ Chinitna Bay
❑ Crescent Lake
❑ Geographic Harbor/Amalik Bay
❑ Hallo Bay
❑ Kukak Bay
❑ Kukaklek Outlet
❑ Kulik River
❑ Moraine Creek/Funnel Creek
❑ Silver Salmon Creek
❑ Twin Lakes/Proenekke's Cabin
❑ Other

❑ I did not visit any of these areas

OR

❑ I do not know the location names of the places I visited

10. What did you enjoy most about your time in the park?

_____

11. What did you enjoy least about your time in the park?

_____

12. The following are conditions or experiences that might influence the quality of a visitor's experience at the park. Please rate the level that the experience increased or decreased the quality of your experience. Please select one for each row.

Possible conditions or experiences in the park	Extremely decreased the quality of my experience	Moderately decreased the quality of my experience	Slightly decreased the quality of my experience	Neither decreased or increased the quality of my experience	Slightly increased the quality of my experience	Moderately increased the quality of my experience	Extremely increased the quality of my experience	Did not experience
Number of planes parked at one location	❑	❑	❑	❑	❑	❑	❑	❑
Number of planes seen in one day	❑	❑	❑	❑	❑	❑	❑	❑
Number of planes heard in one day	❑	❑	❑	❑	❑	❑	❑	
Number of other people encountered in one day	❑	❑	❑	❑	❑	❑	❑	❑
Amount of time other visitors are seen outside my own travel party	❑	❑	❑	❑	❑	❑	❑	❑
Amount of time other visitors are heard outside my own travel party	❑	❑	❑	❑	❑	❑	❑	❑
Amount of time without seeing other visitors outside my own travel party	❑	❑	❑	❑	❑	❑	❑	❑
Amount of time without hearing other visitors outside my own travel party	❑	❑	❑	❑	❑	❑	❑	❑
Number of campsites within sight of me	❑	❑	❑	❑	❑	❑	❑	❑
Amount of sound from other campsites around me	❑	❑	❑	❑	❑	❑	❑	❑
Number of planes landing or taking off close to me	❑	❑	❑	❑	❑	❑	❑	❑
Amount of time without human produced noise	❑	❑	❑	❑	❑	❑	❑	❑
Amount of litter seen	❑	❑	❑	❑	❑	❑	❑	❑
Number of other people viewing a bear	❑	❑	❑	❑	❑	❑	❑	❑
Other visitors' proximity to bears	❑	❑	❑	❑	❑	❑	❑	❑
Your proximity to bears	❑	❑	❑	❑	❑	❑	❑	❑
Amount of the day that wildlife was seen or present	❑	❑	❑	❑	❑	❑	❑	❑
Number of visitors breaking wildlife viewing rules	❑	❑	❑	❑	❑	❑	❑	❑
Interacting with a park ranger	❑	❑	❑	❑	❑	❑	❑	❑
Behaviors of other guides	❑	❑	❑	❑	❑	❑	❑	❑

13. Using the same list from the previous question, please select the most important experience or condition that influenced the quality of your visit.

	Please select the most important experience that influenced the quality of your visit (select one)
Number of planes parked at one location	❑
Number of planes seen in one day	❑
Number of planes heard in one day	
Number of other people encountered	❑
Amount of time other visitors are seen outside my own travel party	❑
Amount of time other visitors are heard outside my own travel party	❑
Amount of time without seeing other visitors outside my own travel party	❑
Amount of time without hearing other visitors outside my own travel party	❑
Number of campsites within sight and sound of me	❑
Amount of sound from other campsites around me	
Number of planes landing or taking off close to me	❑
Amount of time without human produced noise	❑
Amount of litter seen	❑
Number of other people viewing a bear	❑
Other visitors' proximity to bears	❑
Your proximity to bears	❑
Amount of the day that wildlife was seen or present	❑
Number of visitors breaking wildlife viewing rules	❑
Interacting with a park ranger	❑
Behaviors of other guides	❑

14. Please rate the level of appropriateness of each of the following activities.

	Very Inappropriate	Not appropriate	Neutral	Appropriate	Very Appropriate
Schedule my visit during times of high visitor use to reduce impacts on bears.	❑	❑	❑	❑	❑
Leave my group to get better views of bears.	❑	❑	❑	❑	❑
View bears by myself.	❑	❑	❑	❑	❑
View bears as part of a large group of other visitors.	❑	❑	❑	❑	❑
Approach bears to take a photo.	❑	❑	❑	❑	❑
Set up a tripod to take a photo.	❑	❑	❑	❑	❑
Keep my camera equipment spread out around me.	❑	❑	❑	❑	❑
Drop food on the ground to provide bears a food source.	❑	❑	❑	❑	❑
Properly store my food while viewing bears.	❑	❑	❑	❑	❑
Remain at least 10 yards from a bear.	❑	❑	❑	❑	❑
Remain at least 50 yards from a bear.	❑	❑	❑	❑	❑
Remain at least 100 yards from a bear.	❑	❑	❑	❑	❑
Speak loudly to keep bears away.	❑	❑	❑	❑	❑
Encourage bears to approach me.	❑	❑	❑	❑	❑

15. Based on your experiences during this visit, please answer the following questions about the soundscape you experienced. A '5' indicates you neither agree nor disagree.

	Strongly Disagree ←							→ Strongly Agree
The number of times I heard motorized noise interfered with my sense of solitude	❑	❑	❑	❑	❑	❑	❑	❑	❑
The noise level of motorized sounds I heard interfered with my sense of solitude	❑	❑	❑	❑	❑	❑	❑	❑	❑
The amount of time I heard motorized noise interfered with my sense of solitude	❑	❑	❑	❑	❑	❑	❑	❑	❑
The human-caused noise I heard are inappropriate sounds to hear while at Katmai	❑	❑	❑	❑	❑	❑	❑	❑	❑
There were more human-caused noises than I expected at Katmai	❑	❑	❑	❑	❑	❑	❑	❑	❑
I was knowledgeable about the types of sounds I would hear at Katmai prior to my visit	❑	❑	❑	❑	❑	❑	❑	❑	❑
The park has too many non-natural or motorized noises	❑	❑	❑	❑	❑	❑	❑	❑	❑
The park's natural soundscape needs to be preserved/protected	❑	❑	❑	❑	❑	❑	❑	❑	❑
The park's soundscape needs to be restored closer to natural conditions	❑	❑	❑	❑	❑	❑	❑	❑	❑

16. Most of my bear viewing experience was at Brooks Camp in Katmai NPP.

❑ Yes ❑ No

OR ❑ I did not view bears during my visit

17. Did you fish during your visit to the park? (*Please check one.*)

❑Yes → approximately how many fish did you catch during your visit to the park? _____

→ Go to Question #18

❑No → Go to Question #22

18. Please rate your level of satisfaction with the following during your visit to the park.

	Extremely dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Extremely satisfied
Number of fish caught	❑	❑	❑	❑	❑
Frequency of catching fish	❑	❑	❑	❑	❑
Size of the fish I caught	❑	❑	❑	❑	❑
Species or type of fish I caught	❑	❑	❑	❑	❑
Number of fish seen with visible scarring/damage from catch and release	❑	❑	❑	❑	❑

19. Please indicate how the following aligned with your expectations.

	Significantly less than expected	Less than expected	Neither less or more than expected	More than expected	Significantly more than expected
Number of fish caught	❑	❑	❑	❑	❑
Frequency of catching fish	❑	❑	❑	❑	❑
Size of the fish I caught	❑	❑	❑	❑	❑
Species or type of fish I caught	❑	❑	❑	❑	❑

20. The following are conditions or experiences that might influence the quality of an angler's experience while fishing in the park. Please rate the level that the experience increased or decreased the quality of your experience. Please select one for each row.

Possible conditions or experiences while fishing in the park	Extremely decreased the quality of my experience	Moderately decreased the quality of my experience	Slightly decreased the quality of my experience	Neither decreased or increased the quality of my experience	Slightly increased the quality of my experience	Moderately increased the quality of my experience	Extremely increased the quality of my experience	Did not experience
Amount of time you waited to access a desirable fishing location due to the presence of other anglers.	❑	❑	❑	❑	❑	❑	❑	❑
Number of times in one day you were not able to access a desirable fishing location due to the presence of other anglers.	❑	❑	❑	❑	❑	❑	❑	❑
Number of times in one day you were not able to access a desirable fishing location due to the presence of other visitors who were not fishing.	❑	❑	❑	❑	❑	❑	❑	❑
Number of other anglers that you encounter during a single day of fishing.	❑	❑	❑	❑	❑	❑	❑	❑
Proximity of other anglers to you during active fishing time.	❑	❑	❑	❑	❑	❑	❑	❑
Amount of angling related litter seen in one day (e.g., discarded fishing line).	❑	❑	❑	❑	❑	❑	❑	❑
Number of bear encounters that you experienced during one day that interfered with your angling efforts.	❑	❑	❑	❑	❑	❑	❑	❑
Number of fish you caught with visible scarring from previous catches.	❑	❑	❑	❑	❑	❑	❑	❑
Number of other planes visible while fishing.	❑	❑	❑	❑	❑	❑	❑	❑
Number of other boats visible while fishing.	❑	❑	❑	❑	❑	❑	❑	❑
Condition of trails surrounding your fishing location(s).	❑	❑	❑	❑	❑	❑	❑	❑
Condition of plants and vegetation surrounding your fishing location(s).	❑	❑	❑	❑	❑	❑	❑	❑
Amount of time other anglers were visible to you.	❑	❑	❑	❑	❑	❑	❑	❑

21. Using the same list from the previous question, please select the most important experience or condition that influenced the quality of your fishing.

	Please select the most important experience that influenced the quality of your fishing (select one)
Amount of time you waited to access a desirable fishing location due to the presence of other anglers.	❑
Number of times in one day you were not able to access a desirable fishing location due to the presence of other anglers.	❑
Number of times in one day you were not able to access a desirable fishing location due to the presence of other visitors who were not fishing.	❑
Number of other anglers that you encounter during a single day of fishing.	❑
Proximity of other anglers to you during active fishing time.	❑
Amount of angling related litter seen in one day (e.g., discarded fishing line).	❑
Number of bear encounters that you experienced during one day that interfered with your angling efforts.	❑
Number of fish you caught with visible scarring from previous catches.	❑
Number of other planes visible while fishing.	❑
Number of other boats visible while fishing.	❑
Condition of trails surrounding your fishing location(s).	❑
Condition of plants and vegetation surrounding your fishing location(s).	❑
Amount of time other anglers were visible to you.	❑

22. What is your zip code of primary residence? _____

If outside the United States, what is your country of residence? _____

23. In what year were you born? _____

24. What is your gender? *(select one)* ❑ Male ❑ Female ❑

25. What is the highest level of school you have completed? *(select one)*

❑ Less than high school
❑ Some high school
❑ High school graduate
❑ Some college
❑ Two-year college graduate
❑ Four-year college graduate
❑ Graduate or professional degree
❑ Do not wish to answer

26. What is your race? *(select all that apply)*

❑ American Indian or Alaska Native
❑ Asian
❑ Black or African American
❑ Hawaiian or Pacific Islander
❑ Hispanic or Latino/Latina
❑ White
❑ Other
❑ Do not wish to answer

27. Which category best describes your total household income in U.S. dollars during 2017 before taxes? *(select one)*

❑ Less than $24,999
❑ $25,000 to $34,999
❑ $35,000 to $49,99
❑ $50,000 to $74,999
❑ $75,000 to $99,999
❑ $100,000 to $149,999
❑ $150,000 to $199,999
❑ $200,000 or more
❑ 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.

Appendix B: LACL vs. KATM

Indicators of Quality

Independent t-tests were conducted to evaluate whether visitors who indicated each park as their primary destination had statistically significant differences in their responses to the first set of questions, which asked respondents to indicate the level at which each condition increased or decreased the quality of their experience. Responses are on a 7-point Likert scale, where 1 represents a condition that extremely decreased the quality of the visitor's experience, and 7 extremely increased the quality of their experience.

Differences: Responses to both indicator values, degree and direction of influence over the visitor experience, and percent respondents who selected the condition as the most important						
	KATM mean	*LACL mean*	***t-value***	*KATM top*	*LACL top*	***** top difference***
Amount of litter seen	4.18	4.19	**-0.334**	0.0	1.0	**1.0**
Amount of sound from other campsites around me	3.62	3.47	**-0.922**	0.0	0.0	**0.0**
Amount of the day that wildlife was seen or present	5.9	5.61	**-2.087***	18.1	15.6	**2.5**
Amount of time other visitors are heard outside my own travel party	3.79	4.31	**5.753***	0.0	0.0	**0.0**
Amount of time other visitors are seen outside my own travel party	3.9	4.39	**4.958***	0.6	1.0	**0.4**
Amount of time without hearing other visitors outside my own travel party	4.99	5.23	**1.582**	2.6	4.0	**1.4**
Amount of time without human produced noise	5.16	5.29	**0.349**	4.8	8.0	**3.2**
Amount of time without seeing other visitors outside my own travel party	4.91	5.21	**2.256***	4.8	4.5	**0.3**
Behavior of other guides	4.76	4.8	**0.892**	2.6	3.5	**0.9**
Interacting with a park ranger	5.12	5.21	**0.877**	4.2	9.0	**4.8**
Number of campsites within sight of me	3.69	3.59	**-0.588**	0.0	0.0	**0.0**
Number of other people encountered in one day	3.64	4.27	**6.105***	2.3	5.0	**2.7**
Number of other people viewing a bear	3.58	4.12	**5.047***	3.2	2.5	**0.7**
Number of planes heard in one day	3.93	4.21	**2.557***	1.6	1.5	**0.1**
Number of planes landing or taking off close to me	3.66	3.98	**2.796***	0.3	2.0	**1.7**

Number of planes parked at one location	4.12	4.17	**0.753**	0.6	1.0	**0.4**
Number of planes seen in one day	4.12	4.25	**1.544**	1.0	0.5	**0.5**
Number of visitors breaking wildlife viewing rules	3.17	3.13	**0.145**	1.3	1.5	**0.2**
Other visitors' proximity to bears	3.88	4.08	**2.065***	1.0	0.0	**1.0**
Your proximity to bears	5.62	5.66	**-0.306**	47.2	39.2	**8.0**

**difference is significant at $p < 0.05$*

**To determine whether there is a significant different between the groups' responses when asked to select the most important indicator, a Pearson Chi-squared analysis was conducted.

Chi-Square Test			
	Value	*df*	*Asymptotic Significance (2-sided)*
Pearson Chi-Square	33.728*	16	0.006
Likelihood Ratio	35.071	16	0.004
Linear-by-Linear Association	2.406	1	0.121
N of Valid Cases	458		

**17 cells (50.0) have expected count less than 5*

Soundscape Preferences

Independent t-tests were conducted to evaluate whether visitors who indicated each park as their primary destination had statistically significant differences in their responses regarding preferences for soundscapes.

Responses are on a 9-point Likert scale, where 1 represents “strongly disagree”, and 9 represents “strongly agree.”

Differences: Preferences for Soundscapes			
	LACL mean	*KATM mean*	***t-value***
The number of times I heard motorized noise interfered with my sense of solitude	3.84	4.33	**-3.040***
The noise level of motorized sounds I heard interfered with my sense of solitude	3.94	4.37	**-2.447***
The amount of time I heard motorized noise interfered with my sense of solitude	3.87	4.26	**-2.228***
The human-caused noise I heard are inappropriate sounds to hear while at the park	3.49	4.06	**-3.303***
There were more human-caused noises than I expected at the park	3.29	3.74	**-2.320***
I was knowledgeable about the types of sounds I would hear at the park prior to my visit	5.02	5.08	**-0.535**
The park has too many non-natural or motorized noises	3.49	3.86	**-2.041***
The park's natural soundscape needs to be preserved/protected	6.34	6.74	**-2.234***
The park's soundscape needs to be restored closer to natural conditions	4.75	5.12	**-2.199***

**difference is significant at $p < 0.05$*

Appendix D: Online Thresholds Questionnaire 2019-2020

OMB Number: 1024-0224
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: Phadrea Ponds.
Please contact Dr. Ryan Sharp (ryansharp@ksu.edu) or Dr. Matthew Brownlee (mbrownl@clemson.edu) with any questions.

Please enter your 4-digit access code: _____

Section 1: Your Visits to the Park

1. Have you visited any other areas at Katmai National Park, outside of Brooks Camp?

○ Yes

○ No

2. **Please tell us about your backcountry visit. Backcountry is defined for this survey as all areas of the park outside of Brooks Camp at Katmai National Park. When answering the questions to this survey, please refer to your time in the backcountry of your primary destination and not your time at Brooks Camp (if you visited Brooks Camp)**

2a. How many **days** did you spend visiting the park during your current trip?

▼ 1 ... 100

2ai. If you visited for only one day, how many **hours** did you spend in the park?

▼ 1 ... 24

2b. Including your last trip, how many **days in the last five years** (60 months) have you visited the park?

▼ 1 ... 500

2c. Including this year, how many **years** (total) have you visited the park?

▼ 1 ... More than 20

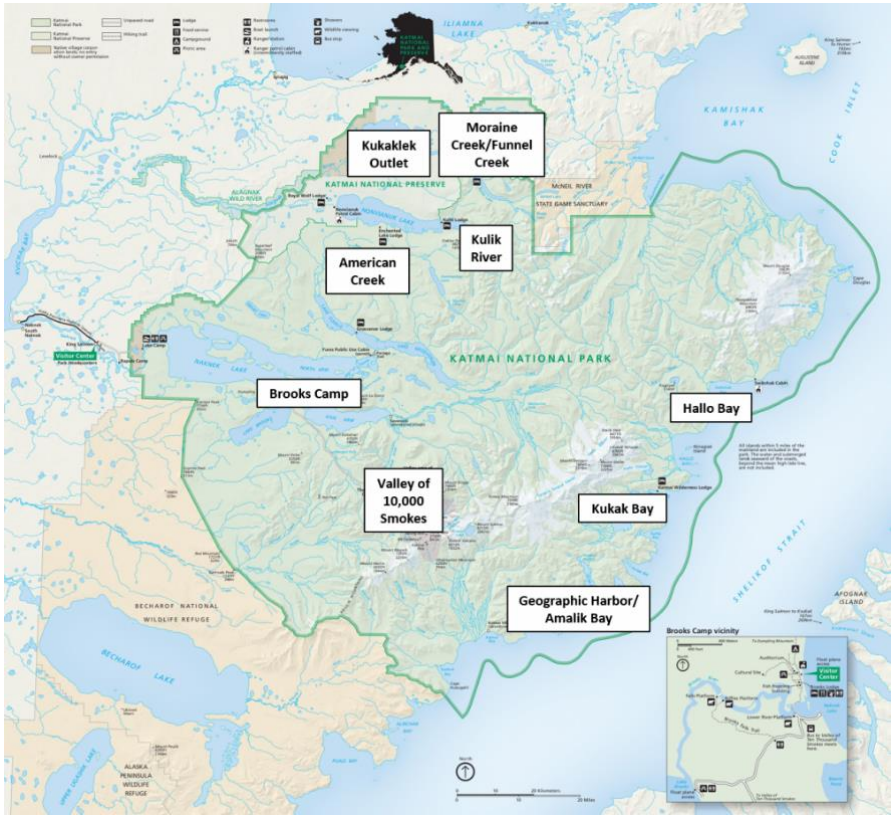
3. During your last visit, what was your **MAIN** reason for visiting the park? **(Select one option)**

- ○ backcountry camping
- ○ backcountry hiking
- ○ bear watching
- ○ boating
- ○ fishing
- ○ flightseeing
- ○ hunting & trapping
- ○ photography
- ○ other, specify: _____

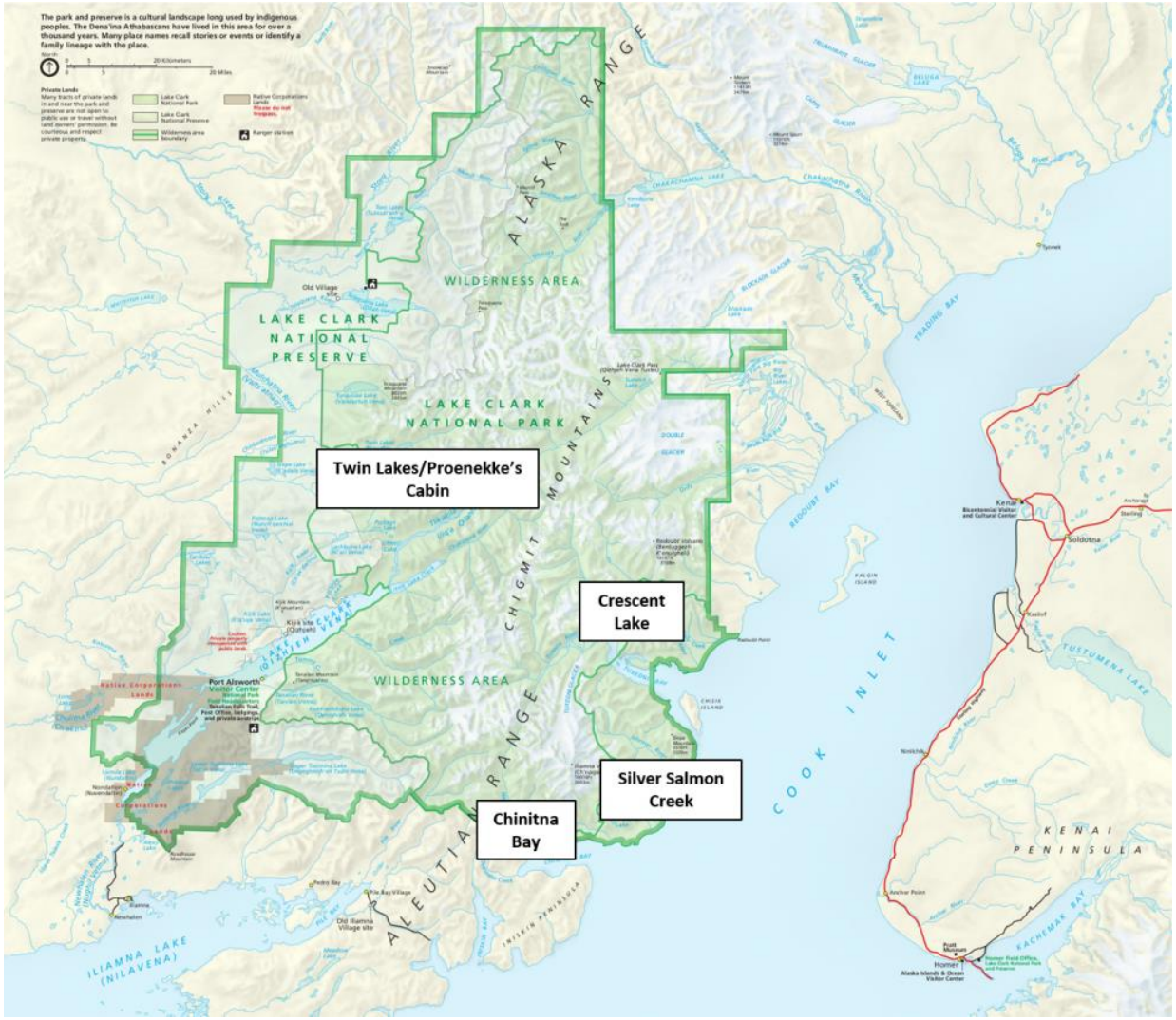
4. During your time in the park **outside** of Brooks Camp (if you visited Brooks Camp), were you accompanied by a professional guide (a guide being someone hired for your experience, not just your pilot)?

- ○ Yes
- ○ No
- ○ I did not visit an area outside of Brooks Camp

5. Please select which of the following locations you visited. Please select all boxes that apply.



5. Please select which of the following locations you visited. Please select all boxes that apply.



6. Please select an option in regard to your visit to the park **if no selections were made** for the previous question. **(Select one option)**

- ○ I did not visit any of these areas
- ○ I do not know the location names of the places I visited
- ○ Other: _____

7. Are there any additional locations that you visited and were not located on the map in the previous question? Please state "No" if there were no additional locations that you visited.

_____

_____

_____

_____

_____

Section 2: Your Opinions About the Backcountry at the Park

For this section, please base your answers on your backcountry experience at the park ONLY. If you have been to Brooks Camp, please DO NOT include that experience in your assessments below.

8. Using the scale below, please rate the level of crowding you experienced during your visit.

- ○ Not crowded
- ○ Barely crowded
- ○ Slightly crowded
- ○ Moderately crowded
- ○ Crowded
- ○ Very crowded
- ○ Extremely crowded

9. We would like to know your opinions about the **number of groups within view at one time** (backcountry only, not at Brooks Camp). Please rate each photo by indicating how acceptable you think it is based on the number of groups within view at one time. **(Select one option for each photo)**

How acceptable is Photo 1?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 2?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 3?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 4?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 5?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 6?	▼ Very Unacceptable ... Very Acceptable

9a. Regarding the number of other groups within view, click on the photo that represents the **conditions you expected to see** during an average day?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ Photo 6

9b. Regarding the number of other groups within view, click on the photo that best represents the **conditions you experienced** during an average day?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ Photo 6

9c. Considering the photo that best represents the average conditions you experienced during your trip, please rate the degree that those conditions either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience
The conditions displayed in the photo that best represents the average conditions you experienced during your trip	○	○	○	○	○

9d. Regarding the number of other groups within view, click on the photo (if any) that displays the conditions at which you believe park managers should take action to improve the conditions?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ Photo 6
- ○ None of the conditions in the photos are so unacceptable that park managers should take action to improve the conditions

9e. Regarding the number of other groups within view, click on the photo (if any) that displays conditions that are so unacceptable that you would no longer visit the area?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ Photo 6
- ○ None of the conditions in the photos are so unacceptable that I would no longer visit the area

10. We would like to know your opinions about **the ideal distance between you and a bear** in order to have a safe and enjoyable experience at the park (backcountry only, not at Brooks Camp). Please rate each photo by indicating how acceptable you think it is based on the distance between you and the bear. **(Select one option for each photo)**

How acceptable is Photo 1?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 2?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 3?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 4?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 5?	▼ Very Unacceptable ... Very Acceptable

10a. Regarding the distance between you and a bear, click on the photo that represents the conditions you **expected to see** during an average day?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5

10b. Which photo best represents the average distance between you and a bear during this visit?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ I did not see any bears during my visit

10c. Which photo best displays the closest distance between you and a bear during your visit?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ I did not see any bears during my visit

10d. In your opinion, what is the distance between you and the bear in this photo? **(Provide answer in yards)**

- ○ Photo 1 _____
- ○ Photo 2 _____
- ○ Photo 3 _____
- ○ Photo 4 _____
- ○ Photo 5 _____

10e. Considering the photo that best represents the average distance between you and a bear during your trip, please rate the degree to which that distance either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience
The conditions displayed in the photo that best represents the average conditions you experienced during your trip	○	○	○	○	○

10f. Regarding the distance between you and a bear, click on the photo (if any) that displays the conditions at which you believe park managers should take action to improve the conditions?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ None of the conditions in the photos are so unacceptable that park managers should take action to improve the conditions

10g. Regarding the distance between you and a bear, click on the photo (if any) that displays conditions that are so unacceptable that you would no longer use the area?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ None of the conditions in the photos are so unacceptable that I would no longer use the area

11. We would like to know your opinions about the ideal number of bears that you could view within a one-hour period at the park during a visit **(backcountry only, not at Brooks Camp)**. Using the scale below, please rate the acceptability of the number of bears that you could view within one hour in the backcountry at the park. **(Select one option for each row)**

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
0-1 bears viewed within one hour	○	○	○	○	○	○	○	○	○
2-3 bears viewed within one hour	○	○	○	○	○	○	○	○	○
4-5 bears viewed within one hour	○	○	○	○	○	○	○	○	○
6-7 bears viewed within one hour	○	○	○	○	○	○	○	○	○
8-9 bears viewed within one hour	○	○	○	○	○	○	○	○	○
10-11 bears viewed within one hour	○	○	○	○	○	○	○	○	○

11a. Which condition listed below is most like **what you expected to see** during an average day?

- ○ 0-1 bears viewed within one hour
- ○ 2-3 bears viewed within one hour
- ○ 4-5 bears viewed within one hour
- ○ 6-7 bears viewed within one hour
- ○ 8-9 bears viewed within one hour
- ○ 10-11 bears viewed within one hour
- ○ Other: Please specify the average number of bears expected to be viewed within one hour

_____

11b. During an average hour in a typical day of your park experience, which condition listed below is most like **what you experienced** during an average day?

- ○ 0-1 bears viewed within one hour
- ○ 2-3 bears viewed within one hour
- ○ 4-5 bears viewed within one hour
- ○ 6-7 bears viewed within one hour
- ○ 8-9 bears viewed within one hour
- ○ 10-11 bears viewed within one hour
- ○ Other: Please specify the average number of bears viewed within one hour

_____

11c. Considering the average number of bears that you viewed within one hour in a typical day at the park during your visit, please rate the degree that those conditions either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience
Average number of bears viewed within one hour during a typical day at the park during your visit	○	○	○	○	○

11d. Which condition listed below do you believe would require park managers to take action to change the backcountry bear viewing experience at the park?

- ○ 0-1 bears viewed within one hour
- ○ 2-3 bears viewed within one hour
- ○ 4-5 bears viewed within one hour
- ○ 6-7 bears viewed within one hour
- ○ 8-9 bears viewed within one hour
- ○ 10-11 bears viewed within one hour
- ○ None of these conditions required park managers to take action to change the bear viewing experience

11e. Which condition listed below is so unacceptable that you would no longer visit the park?

- ○ 0-1 bears viewed within one hour
- ○ 2-3 bears viewed within one hour
- ○ 4-5 bears viewed within one hour
- ○ 6-7 bears viewed within one hour
- ○ 8-9 bears viewed within one hour
- ○ 10-11 bears viewed within one hour
- ○ None of these conditions are so unacceptable that I would no longer use the area

12. We would like to know your opinions about **hearing human produced sounds** during a one-hour period in the backcountry at the park. **For this question, "human sounds" are sounds produced outside of your own travel party by peoples' voices, music, motorized crafts (e.g. boats, planes, generators). (Select one option for each row)**

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
No human sounds during a one-hour period	○	○	○	○	○	○	○	○	○
Hearing human sounds for a total of 15 minutes out of one hour	○	○	○	○	○	○	○	○	○
Hearing human sounds for a total of 30 minutes out of one hour	○	○	○	○	○	○	○	○	○
Hearing human sounds for a total of 45 minutes out of one hour	○	○	○	○	○	○	○	○	○
Hearing human sounds for a total of 60 minutes out of one hour	○	○	○	○	○	○	○	○	○

12a. Which condition listed below is most like **what you expected to experience** during an average day?

	0	15	30	45	60
Total number of minutes during a one-hour period that you would hear human sounds					

12b. During an average hour in a typical day at the park, which condition listed below is most like **what you experienced** during an average day?

	0	15	30	45	60
Total number of minutes during a one-hour period that you heard human sounds					

12c. Considering your answer to the previous question about the average conditions you experienced during your visit, please rate the degree to which those conditions either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience
On average, the total minutes during one hour that you heard human sounds in the backcountry at the park	○	○	○	○	○

12d. Which condition listed below represents the maximum amount of minutes in one hour that you heard human sounds?

	0	15	30	45	60
Total number of minutes during a one-hour period that you heard human sounds					

12e. During an average hour in a typical day at the park, which condition listed below do you believe would require park managers to take action to change the backcountry experience at the park?

	0	15	30	45	60
Total number of minutes during a one-hour period that you heard human sounds					

12f. During an average hour in a typical day at the park, which condition listed below is so unacceptable that you would no longer visit the backcountry at the park?

	0	15	30	45	60
Total number of minutes during a one-hour period that you heard human sounds					

13. We would like to know how many other groups of visitors **(groups defined as 3-6 people)** you think it is acceptable to encounter **per day** while fishing in the park. Please rate the acceptability of each of the following numbers of groups **encountered per day in the park. (Select one option for each row)**

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
No other groups	○	○	○	○	○	○	○	○	○
3 groups	○	○	○	○	○	○	○	○	○
6 groups	○	○	○	○	○	○	○	○	○
9 groups	○	○	○	○	○	○	○	○	○
12 groups	○	○	○	○	○	○	○	○	○
15 groups	○	○	○	○	○	○	○	○	○

13a. Which condition listed below is most like what you **expected to experience** during an average day?

- ○ 0 groups encountered per day
- ○ 3 groups encountered per day
- ○ 6 groups encountered per day
- ○ 9 groups encountered per day
- ○ 12 groups encountered per day
- ○ 15 groups encountered per day

13b. Which condition listed below is most like what you experienced during an average day?

- ○ 0 groups encountered per day
- ○ 3 groups encountered per day
- ○ 6 groups encountered per day
- ○ 9 groups encountered per day
- ○ 12 groups encountered per day
- ○ 15 groups encountered per day

13c. Considering the number of groups that you encountered during your visit, please rate the degree that those conditions either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience
Number of groups encountered per day during an average day	○	○	○	○	○

13d. Which condition listed below do you believe would require park managers to take action to change the backcountry angling at the park?

- ○ 0 groups encountered per day
- ○ 3 groups encountered per day
- ○ 6 groups encountered per day
- ○ 9 groups encountered per day
- ○ 12 groups encountered per day
- ○ 15 groups encountered per day

13e. Which condition listed below is so unacceptable that you would no longer visit the park?

- ○ 0 groups encountered per day
- ○ 3 groups encountered per day
- ○ 6 groups encountered per day
- ○ 9 groups encountered per day
- ○ 12 groups encountered per day
- ○ 15 groups encountered per day

14. We would like to know what you think is an acceptable number of fish caught **per day** with visible scarring from previous catches. Please rate the acceptability of each of the following numbers of **scarred fish caught per day. (Select one option for each row)**

	Very Unacceptable	Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither acceptable or unacceptable	Slightly Acceptable	Moderately Acceptable	Acceptable	Very Acceptable
0 scarred fish	○	○	○	○	○	○	○	○	○
2 scarred fish	○	○	○	○	○	○	○	○	○
4 scarred fish	○	○	○	○	○	○	○	○	○
6 scarred fish	○	○	○	○	○	○	○	○	○
8 scarred fish	○	○	○	○	○	○	○	○	○
10 scarred fish	○	○	○	○	○	○	○	○	○

14a. Which condition listed below is most like what you **expected to see** during an average day?

- ○ 0 scarred fish
- ○ 2 scarred fish
- ○ 4 scarred fish
- ○ 6 scarred fish
- ○ 8 scarred fish
- ○ 10 scarred fish

14b. Which condition listed below is most like what you experienced during an average day?

- ○ 0 scarred fish
- ○ 2 scarred fish
- ○ 4 scarred fish
- ○ 6 scarred fish
- ○ 8 scarred fish
- ○ 10 scarred fish
- ○ I did not catch any fish during my visit

14c. Considering the number of scarred fish that you caught during an average day, please rate the degree that those conditions either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience	I did not catch any fish today
Number of damaged or scarred fish caught	○	○	○	○	○	○

14d. Which condition listed below do you believe would require park managers to take action to change the backcountry angling at the park?

- ○ 0 scarred fish
- ○ 2 scarred fish
- ○ 4 scarred fish
- ○ 6 scarred fish
- ○ 8 scarred fish
- ○ 10 scarred fish

14e. Which condition listed below is so unacceptable that you would no longer visit the park?

- ○ 0 scarred fish
- ○ 2 scarred fish
- ○ 4 scarred fish
- ○ 6 scarred fish
- ○ 8 scarred fish
- ○ 10 scarred fish

14. We would like to know your opinion about different levels of **impact to vegetation surrounding a fishing location**. Please review the photos provided. Next, please select the **acceptability** of the conditions displayed in each of the five photos. **(Select one option for each photo)**

How acceptable is Photo 1?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 2?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 3?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 4?	▼ Very Unacceptable ... Very Acceptable
How acceptable is Photo 5?	▼ Very Unacceptable ... Very Acceptable

14a. Regarding impact to vegetation at a fishing location, click on the photo that represents the conditions you **expected to see** during an average day?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5

14b. Regarding impact to vegetation at a fishing location, click on the photo that best represents the conditions you experienced during an average day?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5

14c. Considering the photos, which best represents the average conditions you experienced during your trip, please rate the degree that those conditions either increased or decreased the quality of your park experience.

	Extremely decreased the quality of my experience	Decreased the quality of my experience	Did not increase or decrease the quality of my experience	Increased the quality of my experience	Extremely increased the quality of my experience
The conditions displayed in the photo that best represents the average conditions you experienced during your trip	○	○	○	○	○

14d. Regarding impact to vegetation at a fishing location, click on the photo (if any) that displays the conditions at which you believe park managers should take action to improve the conditions displayed in the photos?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ None of the conditions in the photos are so unacceptable that park managers should take action to improve the conditions

14e. Regarding impact to vegetation at a fishing location, click on the photo (if any) that displays conditions that are so unacceptable that you would no longer visit the area?

- ○ Photo 1
- ○ Photo 2
- ○ Photo 3
- ○ Photo 4
- ○ Photo 5
- ○ None of the conditions in the photos are so unacceptable that I would no longer visit the area

Section 3: About You

15. What is your zip code?

_____

16. What **year** were you born? (Please enter as a 4-digit value)

_____

17. What is your gender? **(Select one)**

- ○ Male
- ○ Female
- ○ Other

18. What is the highest level of education you have completed? **(Select one)**

- ○ Less than high school
- ○ Some high school
- ○ High school graduate
- ○ Some college
- ○ Two-year college graduate
- ○ Four-year college graduate
- ○ Graduate or professional degree
- ○ Do not wish to answer

19. What is your race? **(Select all that apply)**

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Hawaiian or Pacific Islander
- ☐ Hispanic or Latino/Latina
- ☐ White
- ☐ Other
- ☐ Do not wish to answer

20. Which category best describes your total gross household income in U.S. dollars during 2018? **(Select one)**

- ○ Less than $24,999
- ○ $25,000 to $34,999
- ○ $35,000 to $49,999
- ○ $50,000 to $74,999
- ○ $75,000 to $99,999
- ○ $100,000 to $149,999
- ○ $150,000 to $199,999
- ○ $200,000 or more
- ○ Do not wish to answer

Thank you for your help with this survey! **Please click the arrow to exit the survey.**

Appendix E: Integrating Emotional Affect into Bear Viewing Management and Bear Safety Education

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Parks, Recreation, and Tourism Management

by
John Matthew Nettles
May 2020

Accepted by:
Dr. Matthew Brownlee, Committee Chair
Dr. Jeffery Hallo
Dr. David Jachowski
Dr. Ryan Sharp
Dr. Joy Erlenbach

ABSTRACT

The popularity of viewing wildlife, specifically brown bears (*Ursus arctos*), is increasing rapidly throughout North America, from Yellowstone National Park (NP) to Denali National Park. In addition, population distributions of both humans and brown bears are expanding, creating larger areas of overlap and an increased possibility of human-bear interactions. In order to prevent negative encounters and injury to either species, park managers must continue to work to encourage appropriate behavior among local residents as well as park visitors. Human behavior, however, is a result of many complex factors, including emotion and cognition. Despite this, the effects of emotions on human-wildlife conflict remain unstudied and therefore may limit success of any mitigation efforts. This thesis employs a quantitative self-assessment questionnaire within a sequential exploratory design to understand the relationship between emotion and behavior within the context of human encounters with bears. Results demonstrate significant variation in negative affect across bear encounter scenarios and highlight several areas of uncertainty among respondents. These results are used to develop a set of meaningful recommendations to improve the efficacy of current bear management and safety education.

TABLE OF CONTENTS

Page

TITLE PAGE……i

ABSTRACT……ii

LIST OF TABLES……...v

LIST OF FIGURES……...vii

CHAPTER

1. INTRODUCTION……...1

Introduction…….…1
Problem, Purpose, and Question……..2
Research Approach……..3
Emotion and Behavior…….3
Thesis Structure and Format……6
Literature Cited……8

2. INTEGRATING EMOTIONAL AFFECT INTO BEAR VIEWING MANAGEMENT AND BEAR SAFETY EDUCATION……..11

Introduction……....11
Background……14
Methods……..17
Results……28
Discussion……..40
Conclusion……51
Literature Cited……..52

3. A NATIONAL ASSESSMENT OF KNOWLEDGE REGARDING BEAR SAFETYAND APPROPRIATE BEHAVIOR…….....56

Introduction……...…56
Study Population……...58
Methods……58
Results……...63
Management Implications……76

Table of Contents (Continued)

Page

Limitations…….80
Future Research…….81
Conclusion…….82
Literature Cited……..83

4. DISCUSSION…….……...91

Survey Results…….…..91
Expanding the Results……...92
Limitations…….……94
Future Research…….95

LIST OF TABLES

Table Page

2.1 Mean Intensity of Affective Response to the Nine Setting Treatments……30

2.2 Mean Difference between Appropriateness and Likelihood of Performing Several Potential Actions after Viewing One of Nine Setting Treatments…….32

2.3 Estimated Marginal Means for Intensity of Affective Response to the Three Behavior Treatments……...34

2.4 Mean Difference between Appropriateness and Likelihood of Performing Several Potential Actions after Viewing One of Three Behavior Treatments……..35

2.5 Univariate General Linear Model for the Impact of Previous Bear Safety Education on an Individual's In-the-moment Decision for Both Video Treatments……..36

2.6 Univariate General Linear Model for the Impact of Current Emotion on an Individual's In-the-moment Decision for both Video Treatments…...37

2.7 Univariate General Linear Model for the Impact of Previous Experience on an Individual's In-the-moment Decision for both Video Treatments…...38

2.8 Perceived and Objective Appropriateness of Listed Actions……45

3.1 Locations in which Respondents Report Viewing a Wild Brown (Grizzly) Bear within the Lower 48 States……65

3.2 Respondents' Self-reported Grades for Knowledge of Safe Behavior Around Bears…….68

3.3 Respondents' Self-reported Grades for Knowledge of Safe Behavior Around Bears, Split by Source of Bear Safety Education…….68

3.4 Perceived and Objective Appropriateness of Listed Actions……70

3.5 Resulting F values from Univariate General Linear Models for Appropriateness of Listed Actions……73

List of Tables (Continued)

Table Page

3.6 Estimated Marginal Means and Difference-of-mean Tests for Appropriateness of Listed Actions, Split by Video Treatment……..74

3.7 Estimated Marginal Means and Difference-of-mean Tests for Appropriateness of Listed Actions, Split by Presence of Bears in a Respondent's Home State…….75

3.8 Estimated Marginal Means and Difference-of-mean Tests for Appropriateness of Listed Actions, Split by Source of Bear Safety Information…….……75

LIST OF FIGURES

Figure Page

2.1 Images Shown to Respondents Prior to Viewing the Respective Setting and Behavior Treatment Videos……21

3.1 Images Shown to Respondents Prior to Viewing the Respective Setting and Behavior Treatment Videos……62

3.2 Responses to Questions Regarding an Individual's Past Experience Viewing Brown Bears…….……65

3.3 Images Shown to Respondents to Assess Accuracy in Identifying Bear Species…….……..66

3.4 Responses to Questions Regarding an Individual's Past Experience with Bear Safety Education……...67

3.5 Percent of Sample Unsure of the Appropriateness Regarding Fifteen Potential Actions when Encountering a Bear……76

CHAPTER ONE

INTRODUCTION

Introduction

At the end of the year 2019, nearly 7.8 billion humans inhabited the earth (UN, 2020). This number is expected to approach 10 billion within the next 30 years as population growth begins to slow (Cohen, 2003) Protected areas across the globe attract human settlement and economic development to rural areas (Wittemyer, Elsen, Bean, Burton, & Brashares, 2008). Increasing human presence and development along with increasing appreciation for nature-based recreation among Americans (Cordell, Betz, & Green, 2008) poses a significant threat to the wild lands originally intended for conservation. Outdoor recreation and higher levels of human use can result in stress, fleeing, and population decline for many wildlife species, including desert bighorn sheep (Papouchis, Singer, & Sloan, 2001), North American wood turtles (Garber & Burger, 1995), and brown bears (Nevin and Gilbert 2005). However, the impact of these changes depends on more than just the amount of use. Human behavior largely decides our ability to coexist with the environment and cope with new ecological challenges that arise (Goujon, 2018).

Human behavior though, is subject to influence from many complex factors. In 1994, neurologist Antonio Damasio outlined the significant role of emotions and feelings in human reason. Not only are current actions influenced by these psychological underpinnings, the ability to predict future events and plan appropriate actions may be as well (Damasio, 1994). Despite similar connotations, emotion, mood, and affect all

represent different phenomena. Affect, the simplest of the three, represents a primitive reaction or response to a stimulus and can occur alone or as a component of mood or emotion. Emotion is the complex interaction between sub-events regarding a specific object. These sub-events include core affect, overt behavior, directed attention, cognitive appraisal of a stimulus, connection of emotion to a stimulus, experience of the emotion, and neural and endocrine changes. Unlike affect and mood, emotion requires cognitive awareness and thought. Lastly, mood is similar to emotion but often persists much longer and is more abstract, lacking a specific or immediate cause (Ekkekakis, 2014). Each of these three phenomena, through their impact on planning and decision making, possess the ability to significantly alter the behavior of an individual.

Problem, Purpose, and Question

Within human-wildlife interactions, emotional responses to wildlife are key determinants of decision making. Despite emotion's pivotal role in human behavior, little knowledge exists regarding emotion's impact on human behavior regarding wildlife. As a result, management strategies might be less effective, potentially limiting success to preventative education efforts. Thus, conflict management can improve only if human emotions are assessed in developing future education strategies that target visitors' subconscious and conscious reactions to wildlife.

This study seeks to explore human reactions to specific wildlife conflict scenarios and their potential implications, focusing on responses to bear-viewing among the general American public. Overall, this study addresses the question of how immediate humans' affective responses impact behavioral choices during human-wildlife encounter scenarios.

Research Approach

To address the research question, I employed two quasi-experimental designs within a quantitative exploratory sequential structure. The first phase of my research involved informal in-situ interviews with bear-viewers at Katmai and Lake Clark National Parks and Preserves in Alaska and video capture. The second phase involved developing an online survey instrument to investigate affective responses to various bear encounter scenarios using two quasi-experimental designs; one to assess responses to nine different combinations of the focal bear's sex, age class, and setting, and the other to assess responses to three different bear behaviors. For the third phase, I administered the survey instrument to a representative sample of the general American public using a cross-sectional representative sample through Qualtrics. The fourth and final phase consisted of the statistical analysis of survey results to address the research question.

Emotion and Behavior

Two judgmental heuristics – practical approaches to decision-making, often separated from logic or rationale – may help understand human behavior through understanding mental predictions. The first, representativeness, involves an individual predicting the outcome best represented by the evidence. These intuitive predictions often ignore reliability of the evidence and lead individuals to predict rare events if they happen to be representative (Kahneman & Tversky, 1973). Second is availability, or the process of decision-making by the ease at which relevant solutions come to mind. This leads to systematic biases represented through frequencies of word classes, combinatorial outcomes, and repeated events (Tversky & Kahneman, 1973). The use of these heuristics

can be detrimental when presented with previously unknown situations, such as instances of human-wildlife conflict. The decision, and resulting action, may not be the logical or reasonable solution, but simply the most representative or first available.

Traditional research in judgement and decision making focused on cognitive processes as the basis for uncertain decisions, in both microeconomics and philosophy. However, starting in the 1990's, research began to incorporate emotional processes within decision making. Rather than the previous dichotomy between emotional and cognitive function, the two may be indistinguishable. Emotions not only encode heuristic evaluations, but the precise parameters of cognitive ones as well (Slovic, Peters, Finucane, & MacGregor, 2005). These evaluations are often referred to as the experiential and analytic systems respectively. The experiential system provides fast, nearly automatic, decisions, while the analytic system provides slow, effortful, and conscious decisions. Previously the experiential system received less credit than the analytic system but current wisdom states both are required in rational decision making. Therefore, when informing others about risks, both systems must be addressed (Quartz, 2009).

Furthermore, emotions may be capable of biasing reasoned judgement. Despite the presence of sound logic or knowledge, emotional processes can alter decisions through both perceptual emotional mechanisms and feeling states. For example, individuals make trustworthy decisions based on the friendliness of nearby faces or expect different outcomes based on subconscious understanding of subtle differences in body state or environment (Dolan, 2002). Similar to a feedback loop, emotion provides

an indirect influence on decisions based off of prior experiences, resulting in decisions informed by previous conscious emotional states. Rapid, affective responses perform a similar function regarding current behavior and provide connections between current events and past emotional outcomes (Baumeister, Vohs, Nathan DeWall, & Zhang, 2007). In order to reach rational, successful decisions, both cognitive and emotional aspects must be addressed. Emotion not only informs heuristic decision-making processes, but cognitive processes as well, and effective conflict management requires implementation of both to better inform future actions and reasoned decision making.

Human-wildlife conflict is becoming an urgent issue due to increasing urban expansion, rapid population growth, and increased visitation to popular wildlife areas. The situational factors surrounding these conflict scenarios contribute significantly to behavior and understanding them is required to create effective management strategies (Hayman, Harvey, Mazzotti, Israel, & Woodward, 2014). Furthermore, human behavioral reactions and decision making often determine the outcome of such scenarios. Understanding human behavior, which emotion heavily influences, can greatly impact management efforts to mitigate human-wildlife conflicts (Wieczorek Hudenko, 2012). However, studies seldom address emotional responses to wildlife conflict scenarios, which limits success of conflict management strategies. In order to improve upon current methods, managers should take human emotion into account.

Despite being responsible for only 24 deaths in North America between 2000 and 2015 (Bombieri et al., 2018), brown bears earn a great deal of negative publicity and have warranted significant safety education. However, bears are also easily anthropomorphized

and develop large online followings (Skibins & Sharp, 2018). When in novel or dangerous wildlife encounters where decisions are made immediately, individuals must weigh negative and positive affect with their knowledge of appropriate behavior. Emotion is heavily responsible for decision-making, yet ignored during instructions for safe behavior.

Thesis Structure and Format

The following chapters further address this discrepancy through survey research on emotions and behavior of the general American public when viewing wild brown bears. This thesis consists of four chapters. Chapter 1 provides a brief introduction to the topic and research focus. Chapters 2 and 3 are formatted as scientific journal articles and detail the results of my research. Chapter 4 provides a discussion of the results, including limitations, implications, and possibilities for future research.

Chapter 2 is intended for submission to the journal, *Ecology and Society*, and focuses on understanding immediate emotional reactions, or affective responses, upon viewing bears and the role that this plays in an individual's ability to behave appropriately. A significant portion of bear management requires cooperation from local residents as well as park visitors, but many factors contribute to human behavior. This may be especially true in exciting and novel experiences like bear encounters. Psychologists have developed many theories regarding these factors, particularly the judgmental heuristics of representativeness and availability and the balance between emotional and cognitive processes. Specific research questions for this chapter include 1) how do affective responses to the setting and a bear's sex or age class impact decision-

making among bear viewers, 2) how do affective responses among bear viewers differ as a result of the bear's behavior, and 3) what factors contribute to the decision-making process during a bear encounter. To test this, I conducted a national online self-assessment survey using short videos to depict twelve potential bear encounter scenarios.

Chapter 3 is intended for the journal, *Ursus*, and focuses on understanding the current level of bear safety knowledge among the general American public. With expanding populations of both humans and grizzly bears, interactions between species are bound to occur. These interactions however, often result in trapping, relocating, or euthanizing the bear. Unfortunately, while many of these incidents are easily preventable through proper human behavior, even one mistake could produce multiple generations of problem bears. Not only are residents within bear habitat responsible for behaving properly, but large numbers of tourists and park visitors must as well. To address this area of concern, I conducted an online self-assessment survey to evaluate the bear safety knowledge of the general American public when presented with several bear encounter scenarios. Specific research questions for this chapter were 1) what locations have resulted in the most brown bear sightings among respondents, 2) how accurate are respondents at identifying brown bears, 3) how do respondents view their level of bear safety knowledge, and 4) what factors contribute to a respondent's perceived appropriateness of listed actions.

From the survey results I developed 10 recommendations to improve the efficacy of bear safety education, including provide reasoning and logic behind policies, release

public service announcements, and provide experiential education using photographs, videos, and virtual reality experiences.

Literature Cited

Baumeister, R. F., Vohs, K. D., Nathan DeWall, C., & Zhang, L. (2007). How emotion shapes behavior: Feedback, anticipation, and reflection, rather than direct causation. *Pers Soc Psychol Rev, 11*(2), 167-203. doi:10.1177/1088868307301033

Bombieri, G., Naves, J., Penteriani, V., Selva, N., Fernandez-Gil, A., Lopez-Bao, J. V., …, & Fedriani, J. M. (2018). Brown bear attacks on humans: a worldwide perspective. *Scientific Reports, 9*(8573). doi:10.1038/s41598-019-44341-w

Cohen, J. E. (2003). Human Population: The Next Half Century. *Science*, *302*(5648), 1172–1175.

Cordell, H. K., Betz, C. J., & Green, G. T. (2008). Nature-based Outdoor Recreation Trends and Wilderness. *International Journal of Wilderness*, *14*(2), 7–13.

Damasio, A. (1994). *Descartes Error: Emotion, Reason and the Human Brain*. New York, NY: G.P. Putnam's Sons.

Dolan, R. J. (2002). Emotion, cognition, and behavior. *Science, 298*(5596), 1191. doi:10.1126/science.1076358

Ekkekakis, P. (2014). *Mood, affect, and emotion*

Garber, S. D., & Burger, J. (1995). A 20-Yr Study Documenting the Relationship between Turtle Decline and Human Recreation. *Ecological Applications*, *5*(4), 1151–1162.

Goujon, A. (2018). Human Population Growth. Reference Module in Earth Systems and Environmental Sciences 1907-1912. doi: 10.1016/B978-0-12-409548-9.10755-9.

Hayman, R. B., Harvey, R. G., Mazzotti, F. J., Israel, G. D., & Woodward, A. R. (2014). Who complains about alligators? cognitive and situational factors influence behavior toward wildlife. *Human Dimensions of Wildlife, 19*(6), 481-497. doi:10.1080/10871209.2014.918218

Herrero, S. (1970). Human injury inflicted by grizzly bears. *Science, 170*(3958), 593. doi:10.1126/science.170.3958.593

Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological Review, 80*(4), 237-251. doi:10.1037/h0034747

Nevin, O. T. and B. K. Gilbert. (2005). Measuring the cost of risk avoidance in brown bears: Further evidence of positive impacts of ecotourism. *Biological Conservation, 121*(4), 611-622.

Papouchis, C. M., Singer, F. J., & Sloan, W. B. (2001). Responses of Desert Bighorn Sheep to Increased Human Recreation. *The Journal of Wildlife Management*, *65*(3), 573–582.

Quartz, S. R. (2009). *Reason, emotion and decision-making: Risk and reward computation with feeling* doi://doi.org/10.1016/j.tics.2009.02.003

Slovic, P., Peters, E., Finucane, M. L., & MacGregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology, 24*(4S), S40. doi:10.1037/0278-6133.24.4.S35

Skibins, J. C., & Sharp, R. L. (2018). Binge watching bears: Efficacy of real vs. virtual flagship exposure. *Journal of Ecotourism,* , 1-13. doi:10.1080/14724049.2018.1553977

Tversky, A., & Kahneman, D. (1973). *Availability: A heuristic for judging frequency and probability* doi://doi.org/10.1016/0010-0285(73)90033-9

UN Department of Economic and Social Affairs, Population Division. (2020). World Population by Year. Retrieved from https://www.worldometers.info/world-population/world-population-by-year/

Wieczorek Hudenko, H. (2012). Exploring the influence of emotion on human decision making in Human–Wildlife conflict. *Human Dimensions of Wildlife, 17*(1), 16-28. doi:10.1080/10871209.2012.623262

Wittemyer, G., Elsen, P., Bean, W. T., Burton, A. C. O., & Brashares, J. S. (2008). Accelerated Human Population Growth at Protected Area Edges. *Science*, *321*(5885), 123–126.

CHAPTER TWO

INTEGRATING AFFECT INTO BEAR VIEWING MANAGEMENT AND BEAR SAFETY EDUCATION

Introduction

Bear viewing and its management

Already one of the most popular forms of ecotourism, bear-viewing continues to grow in popularity (Aumiller and Matt 1994, Haroldson and Gunther 2013). The creation of Yellowstone National Park (NP) in 1872 inspired the first recreational bear-viewers and participation in wildlife-related recreation continues to increase (Aumiller and Matt 1994). As interest increases, destinations such as McNeil River State Game Sanctuary in Alaska develop into highly demanded tourist attractions. This site, specifically, provides a guiding example of successful bear-viewing management. After the establishment of their management plan, the sanctuary touts no human injuries or bears requiring removal (lethal or otherwise), despite bear use of the area more than doubling (Aumiller and Matt 1994). Managers at McNeil River claim this is largely a result of their ability to encourage appropriate behavior among visitors.

Previous bear attacks

Unfortunately, when park visitors and local citizens behave inappropriately, both bears and humans can be harmed. While injurious encounters with bears are relatively rare, the result can prove fatal. Canadian biologist, Stephen Herrero (2018) found that from 1900 to 1980, 126 injuries were definitely or very probably inflicted by grizzly bears in North American parks. Of these, 56 occurred in Yellowstone National Park and

24 occurred in Glacier National Park. However, two parks with much larger bear populations, Katmai and Denali National Parks in Alaska, account for only 10 injuries, all of which were in Denali (Herrero 2018). Between 1970 and 1973, Yellowstone reported the highest ratio of visitors per grizzly-inflicted injury at 1,745,142:1, or approximately 0.00006% of the visiting population (Herrero 1976).

In this same time period, sows with cubs were responsible for 8 major injuries and 9 minor injuries, while solitary females were responsible for 1 major injury and adult males were responsible for 1 major and 1 minor injury (Herrero 1976). Among fifty aggressive encounters not resulting in injury, 28 involved a sow with cubs, 2 involved an adult male (5 additional accounts attributed to an adult bear of unknown sex), and 5 involved a subadult (Herrero 1976). Overall, these data suggest interior parks with high visitation and relatively small bear populations produce the highest risk of bear-inflicted injury which, if occurred, would most likely be attributed to a sow with cubs. Despite this potential for danger, visitors often hope for the special experience of being near animals or seeing dependent young (Farber and Hall 2007).

Emotion and behavior

During novel encounters with wildlife, emotional responses are key determinants of decision making, yet are seldom studied. Despite emotion's pivotal role in human behavior, little knowledge exists regarding its impact on human-wildlife conflict management strategies. As a result, management strategies might be less effective, potentially limiting success of preventative education efforts. Thus, human-wildlife conflict management can improve only if human emotions are assessed in developing

future education strategies that target visitors' subconscious and conscious reactions to wildlife. This study seeks to explore human reactions to specific wildlife encounter scenarios and their potential implications, focusing on responses to bear-viewing among the general American public. Many visitors and residents of bear-inhabited regions never receive formal safety education and as populations of both bears and humans expand, negative encounters are likely to continue. Collecting a representative sample of the general American public allows for an unbiased estimate of national awareness regarding safe behavior around bears and potential suggestions for improvement.

The objectives of this paper include to 1) Understand immediate emotional reactions upon viewing bears in different scenarios, including various sexes, age classes, behaviors, and habitat types, and 2) understand the role of emotional reactions in individuals' ability to behave appropriately. Research questions include:

1) How do affective responses to the setting and a bear's sex or age class impact decision-making among bear-viewers?
    a. How do affective responses vary across treatments?
    b. How does the likelihood of performing listed actions vary across treatments?
    c. How does the reported appropriateness of performing listed actions vary across treatments?
    d. For which behaviors are there discrepancies between likelihood and reported appropriateness?

2) How do affective responses to a bear's behavior impact decision-making among bear-viewers?
    a. How do affective responses vary across treatments?
    b. How does the likelihood of performing listed actions vary across treatments?
    c. How does the reported appropriateness of performing listed actions vary across treatments?
    d. For which behaviors are there discrepancies between likelihood and reported appropriateness?
3) What factors contribute to the decision-making process during a bear encounter?

Background

Underpinning these research questions is a body of knowledge about emotion, mood, and affect, which despite similar connotations, all represent different phenomena. Affect, the simplest of the three, represents a primitive reaction or response to a stimulus and can occur alone or as a component of mood or emotion. Emotion is the complex interaction between sub-events regarding a specific object. These sub-events include core affect, overt behavior, directed attention, cognitive appraisal of a stimulus, connection of emotion to a stimulus, experience of the emotion, and neural and endocrine changes. Unlike affect and mood, emotion requires cognitive awareness and thought. Lastly, mood is similar to emotion but often persists much longer and is more abstract, lacking a specific or immediate cause (Ekkekakis 2012).

Two judgmental heuristics – practical approaches to decision-making, often separated from logic or rationale – may help understand human behavior through understanding mental predictions. The first, representativeness, involves an individual predicting the outcome best represented by the evidence. These intuitive predictions often ignore reliability of the evidence and lead individuals to predict rare events if they happen to be representative (Kahneman and Tversky 1973). Second is availability, or the process of decision-making by the ease at which relevant solutions come to mind. This leads to systematic biases represented through frequencies of word classes, combinatorial outcomes, and repeated events (Tversky and Kahneman 1973). The use of these heuristics can be detrimental when presented with previously unknown situations, such as instances of human-wildlife encounters. The decision, and resulting action, may not be the logical or reasonable solution, but simply the most representative or first available (Kahneman and Tversky 1973, Tversky and Kahneman 1973).

Traditional research in judgement and decision making focused on cognitive processes as the basis for uncertain decisions, in both microeconomics and philosophy (Quartz 2009). However, starting in the 1990's, research began to incorporate emotional processes within decision making. Rather than the previous dichotomy between emotional and cognitive function, the two may be indistinguishable. Emotions not only encode heuristic evaluations, but the precise parameters of cognitive ones as well (Slovic et al. 2005). These evaluations are often referred to as the experiential and analytic systems respectively. The experiential system provides fast, nearly automatic decisions, while the analytic system provides slow, effortful, and conscious decisions. Previously

the experiential system received less credit than the analytic system but current wisdom states both are required in rational decision making. Therefore, when informing others about risks, both systems must be addressed (Quartz 2009).

In order to reach rational, successful decisions, both cognitive and emotional aspects must be addressed. Emotion not only informs heuristic decision-making processes, but cognitive processes as well, and effective conflict management requires implementation of both to better inform future actions and reasoned decision making. Integrating such complexity in management efforts requires a multi-disciplinary approach. Items impacting decision-making during an encounter include cognition and emotions, barriers and benefits to specific behavior choices, and social thresholds (Jochum et al. 2014). These dimensions each play a role in determining behavior; however, some may lack effectiveness due to individuals' reliance on affect-based shortcuts.

Wilson (2008) proposed three approaches to alter affect-based shortcuts to improve conservation efforts. Value-focused approaches aim to incorporate an individual's conservation objectives into decisions. Trade-off techniques encourage justification for conservation actions over affective impressions or other values. Lastly, identifying shared values and increasing procedural fairness work to foster trust in decision-making authorities and the decision process (Wilson 2008). Through incorporation of these techniques, managers develop the capacity to edit individuals' affective responses to wildlife encounters, quickly and drastically altering the effectiveness of mitigation efforts.

Methods

Overall design

To best determine how the American public responds emotionally to various bear-encounter scenarios, I used an exploratory sequential design (Cabrera 2011). The first phase of my research involved informal in-situ interviews with bear-viewers at Katmai and Lake Clark National Parks and Preserves in Alaska and video capture. The second phase involved developing an online survey instrument to quantitatively capture affective responses to various bear encounter scenarios using two quasi-experimental designs. In the third phase, I administered the survey instrument to a representative sample of the general American public using a Qualtrics cross-sectional representative sample. The fourth and final phase consisted of the statistical analysis of survey results to address the research question.

This study employed two independent samples designs: a 3x3 design as well as an additional 3x1 design. Each treatment represented a different 15-second video. The first design (3x3), setting treatments, compared visitor responses across three different settings and three different age and sex classes. Settings included a salmon stream, a meadow, and a viewing platform while age and sex classes included solitary boar, sow with cubs, and sub-adults. Study design 2 (3x1), behavior treatments, acted as a qualifier, testing responses across bear behavior, holding other variables constant. The three studied behaviors were feeding, curious, and aggressive, but respondents were not provided with an interpretation or description. Behavior was held constant across the entire 3x3 design but was tested here to alleviate the threat to external validity resulting from the lack of

independence between bear behavior and an individual's response. This second design also served as an additional test of current education efforts and an individual's ability to behave appropriately in such situations.

Phase 1: Informal interviews

Informal interviews

Brief qualitative interviews occurred directly after or during a bear-viewing experience, following approaches recommended by Seidman (2012). These interviews were informal, recorded only through field notes, and looked to capture the current emotions of visitors (Halcomb and Davidson 2006). Questions were open ended to allow the respondent to verbalize their reactions independent of outside influence. Interviews were conducted with as many visitor groups as possible and at multiple locations across Katmai and Lake Clark National Parks to reach data saturation (Seidman 2012). These locations support abundant brown bear populations while providing high quality viewing experiences in all three of the intended settings.

Video capture

To best simulate the nine setting treatments, I captured high quality video clips that effectively demonstrated the intended scenario while minimizing any nuisance variables due to unintended differences across videos, such as lighting, weather, microhabitat, size and positioning of the bear, and video quality. For the three behavior treatments, I elicited videos from online bear-viewing communities, online video sharing sites, and public access documentaries. Videos were selected that displayed only the focal bear and clearly illustrated the intended behavior while minimizing differences due to

microhabitat, lighting, weather, age or sex of the bear, and video quality. All final videos are available online (http://tinyurl.com/Affect-Videos).

Researchers in park and visitor use management often use visual methods, in the form of computer-altered photographs, to help identify outdoor recreationists' ideal conditions (Laven and Krymkowski 2005, Manning, Valliere, and Wang 1999). Photographs depicting varying levels of resource or experiential impact can be used as suggestive surrogates for true conditions (Newman, Marion, and Cahill 2001) and are much more effective than traditional narrative descriptions (Manning and Freimund 2004). While less studied, videos have also been used successfully to determine park visitors' preferred conditions (Bateson and Hui 1992, Freimund et al. 2002). This study would have ideally been conducted in person, but field research would not have allowed the questions to be addressed. Not only would this method be time consuming and expensive, it would be difficult to maintain consistency across scenarios and ensure all types of encounters were represented. As a result, videos were used to best depict first-hand experience of bear behavior and viewing locations, allowing me to design the experiment appropriately while keeping both bears and humans safe and avoiding distractions during onsite experiences. Further research could test the potential of virtual reality in more accurately depicting encounter scenarios or could use an in person qualitative approach to assess emotional reactions on a deeper level immediately following an encounter. This research could occur at several different parks and protected areas to assess reactions to various types of bear viewing using participant observation.

Phase 2: Survey development

For the second phase of the design, I developed an online self-assessment survey of emotional affect towards brown bears (*Ursus arctos)* among the general American public. Surveys used the Positive and Negative Affect Schedule (PANAS scale) to quantify affective reactions of survey respondents. Developed by Watson, Clark, and Tellegen (1988), the PANAS scale is one of the most widely used tools for measuring affect (e.g., Crawford and Henry 2004, Crocker 1997, Jacobs, Fehres, and Campbell 2012, Schmuckle et al. 2002, Thompson 2007). This scale uses a list of twenty adjectives describing various feelings and emotions, ten of which relate to positive affect, and ten to negative affect. Respondents are asked to rate the intensity of each affective item on a five-point scale, with one being "very slightly or not at all" and five being "extremely." This scale exhibits high scale, item, and external validity, is reliable across a range of time instructions from the present moment to general, and provides precise measures of positive and negative affect (Watson et al. 1988).

I included photographs of viewing scenarios and explicit instructions in the survey to encourage respondents to immerse themselves in the video and respond based only on immediate reactions to each video. Figure 2.1 displays the photographs for each setting category (i.e., meadow, stream, and platform). This figure also includes the generic bear viewing photo displayed prior to all three behavior treatments used to further illustrate the viewing scenario.

I developed the survey through an online survey platform, Qualtrics, using best practices for online survey construction as described by Dillman (2011) and Vaske

(2008). Surveys showed each respondent a randomly selected video from the first design, a 3x3 design with three settings and three categories of sex or age class, followed by a question prompting them to rate their level of agreement with all listed adjectives, using the PANAS scale to measure positive and negative affect. Next, surveys showed each respondent a randomly selected video from the second design, a 3x1 design with three bear behavioral categories, followed by the same PANAS scale. Despite efforts to maximize the applicability of videos and the PANAS scale, their use may have hampered the ability to measure true affective responses. This study, then, offers a foundation for future research which could use in depth, onsite, qualitative interviews to better understand the complexities within affective responses.

Figure 2.1. Images shown to respondents prior to viewing the respective setting and behavior treatment videos.

For each video, respondents were asked how they plan to react and the perceived appropriateness of potential actions. Both questions provided a list of fifteen potential actions and a seven-point Likert scale for respondents to rate their level of agreement with each choice. These potential actions were chosen based on historical accounts of reactions listed by Gunther and Hoekstra (1998) and personal accounts from working in bear safety education. The final list was chosen to provide a range of appropriateness and

was listed in alphabetical order. For appropriateness, respondents were given the additional option to select “I don’t know” for each action. Lastly, the respondents rated, on a ten-point Likert scale (1 = not at all, 10 = a great deal), the potential impact of bear safety education, current emotion, and previous experience on their in-the-moment decisions. These questions helped to determine the strength and accuracy of judgmental heuristics (i.e., representativeness and availability) in respondents’ decision-making process.

Phase 3: Sampling

After developing the final survey instrument, I purchased a cross-sectional representative sample study from Qualtrics to collect a representative sample of the general American public. Unless bear safety training is mandatory and standardized, many visitors and residents may encounter a bear without having knowledge of proper behavior. I chose the general American public as the study population to best understand how such individuals will behave in bear encounter scenarios, with or without previous training. Purchasing a cross-sectional representative sample allowed for efficient data collection given the broad sampling population. Qualtrics sampling used six demographic questions and standard U.S. Census Bureau categories as qualifiers to ensure a representative sample. These included age, education level, gender, income, race, and zip code of primary residence.

Phase 4: Analysis

All statistical analyses were conducted using IBM’s Statistics Package for the Social Sciences (SPSS) version 24.0 (2018).

Confirmatory Factor Analysis

To determine fit indices, measurement variance, and item independence for the shortened PANAS scale, I conducted a confirmatory factor analysis (CFA) with robust estimation methods using EQS 6.3. Ultimately, the CFA helps evaluate the psychometric measurement properties of the scale and provides an assessment of scale validation.

Research Question 1: Responses to setting and sex or age class

Research questions 1a, 1b, and 1c asked how the setting of a bear encounter and a bear's sex or age class impact a viewer's intensity of affective responses (question 1a), likelihood of performing listed actions (question 1b), and perceived appropriateness of listed actions (question 1c). To assess differences in responses, I used three multivariate analyses of variance (MANOVAs). This statistical test compares values for multiple continuous or scale dependent variables (i.e., affect items, listed actions) across a categorical independent variable (i.e., video treatments). Assumptions include an independent random sample, independence of dependent variables, multivariate normality, and similar variance across groups. When a difference across video treatments was statistically significant ($p < 0.05$), I used Bonferroni post-hoc tests to assess pair-wise comparisons while minimizing the impact of testing multiple hypotheses on statistical results. For perceived appropriateness, I did not include responses of "I don't know," so results were easily comparable between perceived appropriateness and likelihood.

Research question 1d asked how the difference between likelihood and perceived appropriateness of listed actions differed across setting and a bear's sex or age class. To

assess differences between an individual's responses, I used a paired-samples t-test for each listed action, excluding responses of "I don't know" for perceived appropriateness. This statistical test compares values across two sets of observations. The area of interest is not the difference in group means of likelihood and perceived appropriateness, but how discrepancies in these values differ among individuals. Assumptions include independent observations and normally distributed data with no outliers. In terms of the mean difference, a negative value represents an action that is more likely than appropriate, while a positive value represents an action that is more appropriate than likely.

Research Question 2: Responses to bear behavior

Research questions 2a, 2b, and 2c asked how a bear's behavior impacts a viewer's intensity of affective responses (question 2a), likelihood of performing listed actions (question 2b), and perceived appropriateness of listed actions (question 2c). Since the scales used in these survey questions were also used in questions regarding setting and a bear's sex or age class, an individual's response to the first use of the scale needed to be accounted for in this phase of analysis. To do so in assessing differences among responses, I used three multivariate analyses of covariance (MANCOVAs), with an individual's previous response as a covariate to account for the dependency between the repeated measure. This statistical test compares values of multiple continuous dependent variables (i.e., affect items, listed actions) across a categorical independent variable (i.e., video treatments) while accounting for values of a third variable (i.e., previous response to same scale). Assumptions for a MANCOVA are the same as for a MANOVA; an independent random sample, independence of dependent variables, multivariate

normality, and similar variance across groups. When a difference across video treatments was statistically significant ($p < 0.05$), I used Bonferroni post-hoc tests to assess pair-wise comparisons while minimizing the impact of testing multiple hypotheses on statistical results. For perceived appropriateness, I did not include responses of "I don't know," so results were easily comparable between perceived appropriateness and likelihood.

Research question 2d asked how the difference between likelihood and perceived appropriateness of listed actions differed across bear behavior. To assess differences between an individual's responses, I used a paired-samples t-test for each listed action, excluding responses of "I don't know" for perceived appropriateness. I did not include previous responses as a covariate in this analysis because each individual was only shown one combination of video treatments and the impact of a previous scale response is likely similar for an individual across questions, limiting the impact of previous scale completion on the difference between an individual's responses to these two questions. In terms of the mean difference, a negative value represents an action that is more likely than appropriate, while a positive value represents an action that is more appropriate than likely.

For all analyses using covariates, I calculated the two-tailed Pearson correlation coefficient, r, to confirm the need for their inclusion. This value represents the level of covariation between the variable of interest for the setting and sex or age class treatment and that for the behavior treatment. Values of r between 0.7 and 1.0 or -0.7 and -1.0 represent strong positive or negative linear relationships, respectively.

Research Question 3: Factors in decision-making

Research question 3 asked which factors most contribute to an individual's in-the-moment decision. The tested factors included knowledge of bear safety, current emotional state, and previous experience. To assess the impact of these factors, I conducted a univariate general linear model (GLM) to determine variables associated with each factor. This statistical analysis assesses the accuracy of predictions for a continuous independent variable based on one or more dependent variables. Assumptions include a linear relationship between variables, normally distributed data with limited collinearity, and independent residuals that are relatively constant across the range of the data.

I included demographics, experience use history, and affective responses in the global model, removing variables to maximize the adjusted R^2 value. This value emphasizes the principle of parsimony by providing a measure of the proportion of variation present in the data that is explained by the model (i.e., R^2) while penalizing for each additional independent variable included. For all three final models, I included video treatment, regardless of statistical significance to illustrate its impact, or lack thereof, on decisions.

Results

I received a total of 511 complete responses with approximately 57 responses (*SD* = 4.39) for each of nine setting treatments and 170 responses (*SD* = 7.76) for each of three behavior treatments. For all sample-wide analyses, this produced an overall confidence interval of 4.34% at the 95% confidence level, suggesting a high-quality

sample. To confirm that the sample produced enough statistical power to detect differences in means, I calculated the minimum sample size per cell needed to maintain a power of 0.8. Since statistical power decreases with further segmentation, I determined the minimum sample size required for each of 9 cells within design 1 (i.e., setting treatments). If the true effect size was 0.2, each cell would require a sample size of 43 to produce a power of 0.8 at a significance level of 0.05. If the true effect size was 0.15, each cell would require a sample size of 75. Based on the average observed sample size per cell (n = 57), an effect size of 0.15, and a significance level of 0.05, the resulting statistical power was 0.66. As a result, I am confident in the sample's ability to detect even minor differences in means.

The sample accurately represented the general American public, as estimated by the U.S. Census Bureau (USCB, 2020), with 66.5% identifying as white, 16.6% as Hispanic or Latino/Latina, 18.4% earning less the $24,999 per year, 17.8% earning between $50,000 and $74,999, 14.9% earning between $25,000 and $49,999, 24.1% reporting high school graduate as their highest level of education, 24.1% reporting a four-year college degree as their highest level of education, and 45% identifying as female. Of these responses, 55% reported never seeing a wild brown bear, while 11.2% reported seeing a wild bear but were unsure of the species. In addition, 47.2% reported being taught any form of bear safety. However, it is unlikely that 33% of the sample truly saw a wild brown bear. While it does not impact the validity of results, it does suggest that visitors may respond to black and brown bears in the same manner.

Informal Interviews

As discussed above, the survey used an adjusted version of the PANAS scale, one of the most widely used and tested measures of affect. To minimize burden on the respondent and eliminate items not relevant to a bear viewing experience, I included only adjectives described in the qualitative interviews while maintaining balance between the positive and negative sides. This process resulted in use of 10 of the 20 PANAS items. The five chosen items within positive affect were attentive, alert, enthusiastic, excited, and interested. The five chosen items within negative affect were distressed, hostile, jittery, nervous, and scared.

Confirmatory Factor Analysis

Results of the original CFA demonstrated low factor loadings and cross loadings for two positive affect items: alert and attentive (initial model fit indices: $SB\chi^2 = 1158$, $p < 0.01$, CFI = 0.82, NNFI = 0.82, RMSEA = 0.18, SRMR = 0.181). I then ran an additional CFA, excluding alert and attentive. This model resulted in relatively high factor loadings, with 6 of the 7 above 0.76 and one at 0.54 (modified model fit indices: $SB\chi^2 = 122.7$, $p < 0.01$, CFI = 0.98, NNFI = 0.97, RMSEA = 0.07, SRMR = 0.042). Intuitively, alert and attentive are not limited to positive responses, which might have influenced the cross loadings and low factor loadings. However, alert and attentive are considered by researchers (e.g., Watson et al. 1988) to be positive affect items.

While this second model met the customary levels of fit as described by Byrne (2008) and Kline (2011), these authors advise researchers to interpret fit indices holistically, maintaining theoretical and conceptual validity. Since results for each item

were foundational to this study, I chose to include alert and attentive in all analyses except for those at the factor level. Ultimately, the CFA results suggest that most PANAS items appropriately reflected the intended latent variables or factors of positive affect and negative affect.

Research Question 1: Responses to setting and sex or age class

Question 1a: Affective responses

Among the Positive Affect (PA) items, alert, $F(8, 502) = 1.61$, $p = 0.12$, and excited, $F(8, 502) = 1.67$, $p = 0.10$, varied the most across setting treatments but none were statistically different at the $p > 0.05$ level. Among the Negative Affect (NA) items, distressed, jittery, nervous, and scared were all statistically different, $F(8, 502) > 1.96$, $p < 0.05$, across setting treatments (see Table 1.1). Overall, viewing a sow and cubs in a meadow resulted in a statistically stronger negative reaction than viewing a boar in a meadow, $t(107) = 3.76$, $p < 0.001$, a boar from a platform, $t(113) = 4.56$, $p < 0.001$, or a subadult from a platform, $t(101) = 2.12$, $p = 0.04$.

Table 2.1. *Mean intensity of affective response to the nine setting treatments.*

	Boar	Sow and Cubs	Subadult	Boar	Sow and Cubs	Subadult	Boar	Sow and Cubs	Subadult	
	MEADOW			**STREAM**			**PLATFORM**			***F*(8, 502)**
	Mean (SD)									
Positive Affect										
Alert	3.89 (1.2)	3.73 (1.2)	3.95 (1.1)	3.91 (1.2)	3.69 (1.4)	3.69 (1.3)	3.35 (1.1)	3.49 (1.3)	3.50 (1.4)	1.61
Attentive	3.93 (1.1)	3.80 (1.1)	4.22 (0.9)	3.93 (1.2)	3.72 (1.3)	3.86 (1.3)	3.68 (1.1)	3.84 (1.2)	3.75 (1.3)	1.16
Enthusiastic	3.04 (1.2)	3.31 (1.4)	3.42 (1.3)	3.16 (1.3)	3.24 (1.3)	2.98 (1.4)	3.40 (1.2)	3.41 (1.4)	3.40 (1.2)	0.94
Excited	3.37 (1.2)	3.53 (1.1)	3.78 (1.1)	3.25 (1.2)	3.36 (1.4)	3.30 (1.4)	3.75 (1.2)	3.52 (1.3)	3.79 (1.1)	1.67
Interested	3.80 (1.2)	3.95 (1.1)	3.92 (1.2)	3.82 (1.0)	3.74 (1.4)	3.54 (1.4)	3.88 (1.1)	3.89 (1.2)	3.90 (1.4)	0.60
Total PA	10.20 (3.0)	10.78 (3.2)	11.13 (3.1)	10.24 (3.3)	10.34 (3.6)	9.82 (3.8)	11.03 (2.9)	10.82 (3.4)	11.08 (3.2)	1.13
Negative Affect										
Distressed	1.8 (1.0)	2.42 (1.3)[2]	2.02 (1.1)	2.15 (14)	1.97 (1.1)	2.29 (1.4)	1.70 (1.1)	1.67 (1.2)[1]	2.02 (1.1)	2.53**
Hostile	1.69 (1.8)	2.13 (1.4)	1.73 (1.2)	1.64 (1.1)	1.52 (1.0)	1.88 (1.3)	1.55 (1.0)	1.62 (1.2)	1.98 (1.3)	1.65
Jittery	1.94 (1.1)[1]	2.76 (1.2)[2]	2.42 (1.2)	2.25 (1.4)	2.22 (1.3)	2.43 (1.3)	1.97 (1.2)[1]	1.80 (1.4)[1]	2.15 (1.3)	3.10**
Nervous	2.22 (1.1)[1]	3.13 (1.3)[2]	2.61 (1.3)	2.49 (1.4)	2.43 (1.3)	2.43 (1.4)	1.87 (1.1)[1]	1.92 (1.3)[1]	2.35 (1.4)	4.93**
Scared	2.22 (1.2)	2.96 (1.4)[2]	2.72 (1.2)	2.44 (1.4)	2.16 (1.1)[1]	2.64 (1.4)	2.00 (1.2)[1]	1.92 (1.3)[1]	2.56 (1.5)	4.34**
Total NA	9.87 (4.3)[1]	13.40 (5.4)[2]	11.50 (5.1)	10.96 (5.9)	10.29 (4.8)	11.66 (6.3)	9.08 (5.7)[1]	8.93 (5.7)[1]	11.06 (5.8)	3.91**

Note. Intensity was ranked by respondents on a five-point scale with one representing "very slightly or not at all" and five representing "extremely." Superscripts represent significant differences across rows at the $p < 0.05$ level. Total PA does not include alert or attentive.

*$p < 0.05$ **$p < 0.01$

Questions 1b and 1c: Likelihood and appropriateness of performing listed actions

When asked to rate the likelihood of performing each of several potential actions on a scale from one to seven (1 = extremely unlikely, 7 = extremely likely), the most likely actions were back away slowly (M = 5.37, SD = 1.8), group together (M = 4.16, SD = 2.0), stand still and wait for the bear to leave (M = 4.73, SD = 1.8), and walk around the bear (M = 4.51, SD = 2.2). However, the actions perceived as most appropriate, on a scale of one to seven (1 = extremely inappropriate, 7 = extremely appropriate), were back away slowly (M = 5.57, SD = 1.6), group together (M = 4.33, SD = 2.0), stand still and wait for the bear to leave (M = 4.77, SD = 1.8), try to hide (M = 4.09, SD = 2.0), and walk around the bear (M = 4.64, SD = 2.1).

Question 1d: Discrepancies between likelihood and perceived appropriateness

Of the 135 combinations of setting videos and potential actions, fifteen showed statistical differences between likelihood and perceived appropriateness (see Table 2.2), meaning respondents may be aware of correct behavior but are either unable to resist participating in inappropriate behavior (i.e., more likely than appropriate; negative value) or unwilling to participate in appropriate behavior (i.e., more appropriate than likely; positive value). Across all setting treatments, backing away slowly, $t(498) = 2.95$, $p = 0.003$, climbing a tree, $t(481) = 3.82$, $p < 0.001$, grouping together to appear larger, $t(482) = 2.40$, $p = 0.017$, playing dead, $t(486) = 4.49$, $p < 0.001$, and walking around the bear, $t(476) = 2.41$, $p = 0.017$, were generally seen as more appropriate than likely.

Table 2.2. *Mean difference between perceived appropriateness and likelihood of performing several potential actions after viewing one of nine setting treatments.*

	Boar	Sow and Cubs	Subadult	Boar	Sow and Cubs	Subadult	Boar	Sow and Cubs	Subadult	
Action	**MEADOW**			**STREAM**			**PLATFORM**			**MEAN (SD)**
	Mean Difference (SD)									
Approach the bear	-0.06 (1.4)	-0.07 (0.9)	-0.11 (1.3)	-0.04 (1.1)	-0.09 (1.5)	-0.16 (1.5)	0.03 (1.2)	-0.05 (1.5)	0.13 (1.6)	-0.05 (1.3)
Back away slowly	-0.02 (1.6)	0.39 (1.6)	0.19 (1.5)	0.24 (1.9)	0.61 (1.4)**	-0.35 (1.6)	0.54 (2.0)*	0.37 (1.4)*	-0.02 (2.4)	0.23 (1.7)**
Climb a tree	0.00 (1.3)	0.54 (1.4)**	0.44 (1.6)*	-0.06 (1.7)	0.32 (1.7)	0.25 (2.0)	0.39 (1.6)	0.33 (1.7)	0.33 (2.0)	0.29 (1.6)**
Kick or punch the bear	0.06 (1.4)	0.41 (1.8)	0.00 (1.7)	-0.19 (0.8)	-0.11 (1.2)	-0.15 (2.2)	0.14 (1.5)	0.27 (1.4)	-0.35 (1.5)	0.02 (1.5)
Group together	0.14 (1.8)	0.28 (1.4)	0.24 (1.6)	0.25 (1.1)	0.35 (1.5)	0.04 (1.6)	0.05 (1.5)	0.24 (1.5)	-0.07 (2.2)	0.17 (1.6)*
Play dead	0.33 (1.6)	0.30 (1.5)	0.33 (1.7)	0.40 (1.3)*	1.09 (2.0)**	0.21 (2.0)	0.29 (1.4)	0.26 (1.8)	-0.09 (2.1)	0.35 (1.7)**
Run away	-0.51 (1.6)*	-0.09 (1.4)	-0.15 (.7)	-0.09 (1.3)	-0.11 (1.5)	0.02 (2.1)	0.07 (1.4)	-0.17 (1.9)	-0.17 (1.8)	-0.13 (1.7)
Shout or make noise	0.00 (1.5)	-0.04 (1.6)	-0.05 (1.6)	0.02 (1.8)	0.55 (1.3)**	-0.15 (1.9)	-0.07 (1.4)	-0.10 (1.6)	0.02 (1.9)	0.02 (1.6)
Shoot the bear	-0.32 (1.7)	0.11 (1.3)	0.31 (1.2)*	0.04 (0.8)	-0.24 (1.0)	0.02 (1.7)	-0.02 (1.5)	-0.10 (1.3)	0.22 (1.9)	0.00 (1.4)
Spray with bear spray	-0.16 (1.8)	0.04 (1.3)	0.00 (1.1)	-0.13 (1.8)	-0.07 (1.2)	0.02 (1.6)	-0.07 (1.3)	-0.15 (1.5)	0.05 (1.9)	-0.05 (1.5)
Stand still and wait	0.27 (1.7)	0.39 (1.5)	0.03 (1.9)	0.38 (1.5)	-0.18 (1.3)	-0.12 (1.9)	-0.22 (1.6)	0.10 (1.5)	-0.02 (1.9)	0.06 (1.6)
Throw food into woods	-0.21 (1.6)	-0.04 (1.5)	-0.16 (1.8)	0.12 (1.4)	0.47 (1.5)*	-0.17 (1.9)	0.39 (1.6)	-0.38 (1.3)*	0.16 (1.9)	0.01 (1.6)
Throw things at the bear	-0.24 (1.6)	-0.11 (1.4)	-0.37 (1.3)*	-0.15 (1.0)	0.16 (1.3)	-0.11 (1.4)	-0.15 (1.1)	-0.13 (1.5)	0.36 (1.9)	-0.10 (1.4)
Try to hide	-0.15 (1.9)	0.31 (1.5)	0.33 (2.0)	0.17 (1.5)	0.26 (1.6)	-0.02 (1.6)	0.05 (1.4)	0.28 (1.3)	-0.11 (2.0)	0.13 (1.7)
Walk around the bear	0.02 (1.6)	0.15 (1.2)	-0.20 (1.9)	0.43 (1.4)*	0.59 (1.8)*	0.31 (1.8)	0.20 (1.8)	0.27 (1.5)	-0.11 (2.0)	0.18 (1.7)*

Note. Likelihood and appropriateness were each ranked on a seven-point scale with one representing “extremely unlikely” or “extremely inappropriate” and seven representing “extremely likely” or “extremely appropriate.” Negative values represent actions that are more likely than appropriate.

For results of the paired samples *t*-tests: $*p < 0.05$, $**p < 0.01$

Research Question 2: Responses to bear behavior

Question 2a: Affective responses

Across all positive and negative affect items, intensity differed significantly, $F(2, 507) > 3.014$, $p < 0.05$, across behavior treatments. For three positive items, enthusiastic, $F(2, 507) = 12.61$, $p < 0.001$, excited, $F(2, 507) > 3.81$, $p < 0.02$, and interested, $F(2, 507) = 23.40$, $p < 0.001$, the intensity of affective responses decreased statistically with more aggressive behaviors. However, for the other two positive items, alert, $F(2, 507) = 11.56$, $p < 0.001$, and attentive, $F(2, 507) = 8.84$, $p < 0.001$, affective responses to the feeding video were statistically less intense compared to both the curious and aggressive videos. For all items within negative affect, intensity increased statistically with more aggressive behaviors (Distressed: $F(2, 507) = 71.72$, $p < 0.001$, Hostile: $F(2, 507) = 26.48$, $p < 0.001$, Jittery: $F(2, 507) = 55.58$, $p < 0.001$, Nervous: $F(2, 507) = 41.41$, $p < 0.001$, Scared: $F(2, 507) = 43.48$, $p < 0.001$). See Table 2.3.

Questions 2b and 2c: Likelihood and appropriateness of performing listed actions

The most likely actions among respondents were back away slowly (*EMM* = 5.40, *SE* = 0.1), group together (*EMM* = 4.27, 0.1), stand still and wait for the bear to leave (*EMM* = 4.65, *SE* = 0.1), and walk around the bear (*EMM* = 4.41, *SE* = 0.1). The actions viewed as most appropriate were largely the same, including back away slowly (*EMM* = 5.39, *SE* = 0.1), group together (*EMM* = 4.46, *SE* = 0.1), stand still and wait for the bear to leave (*EMM* = 4.74, *SE* = 0.1), try to hide (*EMM* = 4.07, *SE* = 0.1), and walk around the bear (*EMM* = 4.64, *SE* = 0.1).

Table 2.3. *Estimated marginal mean for intensity of affective responses to the three behavior treatments.*

	Feeding	Curious	Aggressive	$F(2, 507)$	r
	Estimated Marginal Mean (SE)				
Positive Affect					
Alert	3.90 (0.1)[1]	4.30 (0.1)[2]	4.38 (0.1)[2]	11.56**	0.47**
Attentive	3.92 (0.1)[1]	4.19 (0.1)[2]	4.36 (0.1)[2]	8.84**	0.51**
Enthusiastic	3.13 (0.1)[2]	2.74 (0.1)[1]	2.53 (0.1)[1]	12.61**	0.47**
Excited	3.36 (0.1)[2]	3.07 (0.1)	3.04 (0.1)[1]	3.81*	0.46**
Interested	3.71 (0.1)[2]	3.44 (0.1)[2]	2.86 (0.1)[1]	23.40**	0.42**
Total PA	10.20 (0.2)[3]	9.23 (0.2)[2]	8.45 (0.2)[1]	16.83**	0.55**
Negative Affect					
Distressed	2.22 (0.1)[1]	3.09 (0.1)[2]	3.67 (0.1)[3]	71.72**	0.42**
Hostile	1.81 (0.1)[1]	2.13 (0.1)[2]	2.62 (0.1)[3]	26.48**	0.60**
Jittery	2.38 (0.1)[1]	3.27 (0.1)[2]	3.66 (0.1)[3]	55.58**	0.36**
Nervous	2.72 (0.1)[1]	3.51 (0.1)[2]	3.86 (0.1)[3]	41.41**	0.36**
Scared	2.71 (0.1)[1]	3.48 (0.1)[2]	3.91 (0.1)[3]	43.50**	0.40**
Total NA	11.85 (0.3)[1]	15.47 (0.4)[2]	17.71 (0.3)[3]	75.45**	0.48**

Note. Intensity was ranked by respondents on a five-point scale with one representing "very slightly or not at all" and five representing "extremely." Superscripts represent significant differences across rows at the $p < 0.05$ level. The two-tailed Pearson correlation coefficient, r, represents the strength of the correlation between intensity of response for the behavior and setting videos. Total PA does not include alert or attentive.

*$p < 0.05$ **$p < 0.01$

Question 2d: Discrepancies between likelihood and perceived appropriateness

Of the 45 combinations of behavior video and potential actions provided, seven showed statistical differences between likelihood and perceived appropriateness (see Table 2.4). Across all behavior treatments, climbing a tree, $t(484) = 3.01$, $p = 0.003$, grouping together to appear larger, $t(477) = 2.47$ $p = 0.014$, playing dead, $t(482) = 3.86$, $p < 0.001$, trying to hide, $t(481) = 2.59$, $p = 0.010$, and walking around the bear, $t(477) = 3.77$, $p < 0.001$, were generally seen as more appropriate than likely.

Table 2.4. *Mean difference between appropriateness and likelihood of performing several potential actions after viewing one of three behavior treatments.*

Action	Feeding	Curious	Aggressive	Mean (SD)	r
	Mean Difference (SD)				
Approach the bear	-0.01 (1.1)	0.02 (1.0)	0.04 (1.3)	0.02 (1.1)	0.15**
Back away slowly	0.05 (1.7)	-0.06 (1.4)	-0.05 (1.8)	-0.02 (1.7)	0.27**
Climb a tree	0.18 (1.8)	0.22 (1.3)*	0.26 (1.6)*	0.22 (1.6)**	0.22**
Kick or punch the bear	0.02 (1.3)	0.02 (1.1)	-0.16 (1.5)	-0.04 (1.3)	0.18**
Group together	0.14 (1.5)	0.19 (1.5)	0.20 (1.7)	0.18 (1.6)*	0.25**
Play dead	0.32 (1.5)**	0.38 (1.5)**	0.08 (1.4)	0.26 (1.5)**	0.18**
Run away	0.14 (1.7)	-0.03 (1.2)	-0.15 (1.7)	-0.01 (1.5)	0.17**
Shout or make noise	-0.05 (1.5)	0.06 (1.3)	0.18 (1.8)	0.06 (1.6)	0.10*
Shoot the bear	-0.01 (1.3)	-0.07 (1.3)	0.16 (1.5)	0.03 (1.4)	0.24**
Spray with bear spray	-0.06 (1.2)	-0.04 (1.3)	0.02 (1.6)	-0.02 (1.4)	0.16**
Stand still and wait	0.12 (1.7)	0.07 (1.4)	0.15 (1.6)	0.12 (1.6)	0.22**
Throw food into woods	0.17 (1.5)	0.08 (1.6)	0.10 (1.9)	0.12 (1.7)	0.16**
Throw things at the bear	0.00 (1.3)	0.19 (1.2)	-0.13 (1.3)	0.02 (1.3)	0.20**
Try to hide	0.14 (1.8)	0.29 (1.3)**	0.14 (1.5)	0.19 (1.6)**	0.17**
Walk around the bear	0.14 (1.6)	0.27 (1.4)*	0.45 (1.9)**	0.29 (1.7)**	0.25**

Note. Likelihood and appropriateness were each ranked on a seven-point scale with one representing "extremely unlikely" or "extremely inappropriate" and seven representing "extremely likely" or "extremely appropriate." A negative value represents an action more likely than appropriate. Superscripts represent significant differences across rows at the $p < 0.05$ level. The two-tailed Pearson correlation coefficient, r, represents the strength of the correlation between intensity of response for the behavior and setting videos.

For results of the paired samples *t*-tests: $*p < 0.05$, $**p < 0.01$

Research Question 3: Factors in decision-making

Bear safety education

For the impact of bear safety knowledge on a respondent's in-the-moment decision, seven independent variables were statistically significant, $F(19, 1002) = 12.75$, $p < 0.001$, adjusted $R^2 = 0.179$ (see Table 2.5). These were previous bear safety instruction, general feelings towards bears, respondent age, and the affective items of alert, attentive, interested, and hostile. The adjusted R^2 value of 0.179 suggests the model explains approximately 18% of the variation in the anticipated impact of previous bear safety education on an in-the-moment decision. The impact of bear safety education was

greater among respondents who had participated in a bear safety training, $F(2, 1002) = 7.96$, B = 1.17, $SE = 0.42$, $p < 0.001$. Additionally, increased positive feelings towards bears, $F(1, 1002) = 23.79$, B = 0.231, $SE = 0.05$, $p < 0.001$, respondent age, $F(1, 1002) = 19.26$, B = 0.02, $SE = 0.01$, $p < 0.001$, alertness, $F(1, 1002) = 13.86$, B = 0.333, $SE = 0.09$, $p < 0.001$, attentiveness, $F(1, 1002) = 10.66$, B = 0.311, $SE = 0.05$, $p = 0.001$, and interest, $F(1, 1002) = 12.17$, B = 0.219, $SE = 0.06$, $p = 0.001$, all resulted in an increased impact of bear safety education on decision-making. However, increased feelings of hostility decreased the impact of safety education, $F(1, 1002) = 9.74$, B = -0.189, $SE = 0.06$, $p = 0.002$.

Table 2.5. *Univariate general linear model for the impact of previous bear safety education on an individual's in-the-moment decision for both video treatments.*

Action	df	F	B (SE)	Adjusted R^2
Corrected model	19	12.8**		0.18
Intercept	1	46.5**	3.47 (0.6)	
Video treatment	11	1.0		
Taught bear safety-Yes	2	8.0*	1.17 (0.4)	
Feelings towards bears	1	23.8**	0.23 (0.0)	
Age	1	19.3**	0.02 (0.0)	
Alert	1	13.9**	0.33 (0.1)	
Attentive	1	10.7**	0.31 (0.1)	
Interested	1	12.2**	0.22 (0.1)	
Hostile	1	9.7**	-0.19 (0.1)	

Note. *$p < 0.05$ **$p < 0.01$

Current emotion

For the impact of emotion on a respondent's in-the-moment decision, four independent variables were significant, $F(15, 1002) = 6.34$, $p < 0.001$, adjusted $R^2 = 0.086$ (see Table 2.6). These were the affective items of attentive, interested, hostile, and scared. The adjusted R^2 value of 0.07 suggests the model explains approximately 7% of the variation in the anticipated impact of current emotion on an in-the-moment decision and as a result, does little to predict this impact. However, for all four significant independent variables, an increase in the intensity of the affective response resulted in an increased impact of emotion on decision-making (Attentive: $F(1, 1002) = 8.99$, B = 0.023, $SE = 0.08$, $p = 0.003$, Interested: $F(1, 1002) = 7.25$, B = 0.184, $SE = 0.07$, $p = 0.007$, Hostile: $F(1, 1002) = 16.35$, B = 0.288, $SE = 0.07$, $p < 0.001$, Scared: $F(1, 1002) = 13.34$, B = 0.262, $SE = 0.07$, $p < 0.001$).

Table 2.6. *Univariate general linear model for the impact of current emotion on an individual's in-the-moment decision for both video treatments.*

Action	df	F	B (SE)	Adjusted R^2
Corrected model	15	6.3^{**}		0.07
Intercept	1	82.7^{**}	2.89 (0.4)	
Video treatment	11	0.8		
Attentive	1	9.0^{**}	0.23 (0.1)	
Interested	1	7.2^{**}	0.18 (0.1)	
Hostile	1	16.3^{**}	0.29 (0.1)	
Scared	1	13.3^{**}	0.26 (0.1)	

Note. $^{*}p < 0.05$ $^{**}p < 0.01$

Previous experience

Lastly, for the impact of previous experience on a respondent's in-the-moment decision, six independent variables were significant, $F(17, 1002) = 8.00$, $p < 0.001$, adjusted $R^2 = 0.104$ (see Table 2.7). These were having seen a bear, general feelings towards bears, self-reported grade in bear safety, and the affective items of attentive, enthusiastic, and scared. The adjusted R^2 value of 0.104 suggests the model explains approximately 10% of the variation in the anticipated impact of previous experience on an in-the-moment decision. Respondents who had not previously seen a bear of any species reported a lower impact of previous experience, $F(1, 1002) = 12.11$, B = -0.659, $SE = 0.20$, $p = 0.001$. More positive feelings towards bears, $F(1, 1002) = 9.74$, B = 0.223, $SE = 0.06$, $p = 0.001$, higher bear safety grades, $F(1, 1002) = 8.66$, B = 0.086, $SE = 0.03$, $p = 0.003$, and increasing levels of attentiveness, $F(1, 1002) = 10.56$, B = 0.284, $SE = 0.09$, $p = 0.001$, enthusiasm, $F(1, 1002) = 8.06$, B = 0.222, $SE = 0.08$, $p = 0.005$, and fear, $F(1, 1002) = 21.03$, B = 0.351, $SE = 0.08$, $p < 0.001$ all resulted in an increased impact of previous experience on decision-making.

Table 2.7. *Univariate general linear model for the impact of previous experiences on an individual's in-the-moment decision for both video treatments.*

Action	df	F	B (SE)	Adjusted R^2
Corrected model	17	8.0**		0.10
Intercept	1	5.3*	0.43 (0.6)	
Video treatment	11	1.7		
Ever seen a bear-No	1	10.4**	-0.66 (0.2)	
Feelings towards bears	1	12.1**	0.22 (0.1)	
Reported bear safety grade	1	8.7**	0.09 (0.0)	
Attentive	1	10.6**	0.28 (0.1)	
Enthusiastic	1	8.1**	0.22 (0.1)	
Scared	1	21.0**	0.35 (0.1)	

Note. *$p < 0.05$ **$p < 0.01$

Strategies to encourage safe behavior

Additionally, I asked respondents to rank the importance of three strategies to encourage safe behavior. Using the approaches to overcoming affective shortcuts detailed by Wilson (2008), I included 1) being told why instructions or policies are what they are, 2) relating with the goals of park managers, and 3) using your own personal values to justify safe behavior. Of 508 complete responses, 66.3% selected strategy one as the most important, 53.0% selected strategy two as the second most important, and 61.8% selected strategy three as the least important.

Discussion

I used a quantitative, exploratory sequential design, to understand both the immediate emotional reactions upon viewing bears in different scenarios and the role of emotional reactions in individuals' ability to behave appropriately. Survey results suggest respondents are generally aware of appropriate behavior around brown bears, but affective responses may hamper their ability to behave accordingly.

Encouraging appropriate behavior

With increasing interest in outdoor recreation, rising visitation levels to parks and protected areas, and expanding brown bear populations, the frequency of human-bear interactions may likely continue to increase. Unfortunately, many individuals will not know how to behave and could cause injury to themselves or a bear. It is the responsibility of park managers and staff to encourage appropriate behavior among park visitors. Individuals must not only be familiar with bear safety, but comfortable enough to

act appropriately when forced to make in-the-moment decisions in the presence of large, novel, and potentially dangerous wildlife.

As suggested by the linear model analysis, different encounter scenarios may result in different behavioral strategies. Scenarios that result in feelings of attentiveness, hostility, and fear may decrease the impact of safety education on behavioral choices while increasing the impact of previous experiences and current emotion. However, among setting treatments, a subadult in a meadow produced the highest level of attentiveness and levels of hostility and fear were both highest in response to a sow and cubs in a meadow. While these affective responses are highly appropriate for the given scenario, they unfortunately increase the impact of current emotion on decision making and could encourage inappropriate behavior.

Similarly, among behavior treatments, the level of attentiveness was higher for curious and aggressive behaviors than feeding behavior and levels of hostility and fear both increased as the behavior treatment increased in aggressiveness. So, as the scenarios become more dangerous and require careful decisions, the more impact emotion has on behavior. In order to continue improving the current effectiveness of bear safety and education efforts, the impact of affective responses must be overcome. Respondents' ranking of potential education strategies stress the potential benefits of explaining to park visitors why instructions and policies were put in place and how they work.

Affective responses

Encouragingly, respondents viewing a sow and cubs in a meadow reported the highest levels of negative affect, followed by a subadult in a stream. These two

treatments represent the setting with the highest potential for danger and the setting with the most erratic behavior (Herrero 1976, 2018). Interestingly, those viewing a sow and cubs from a platform reported the lowest levels of negative affect. This suggests that despite high levels of positive affect, respondents recognized the potential for danger when viewing a sow and cubs while exposed in a meadow. When viewing from a platform, a significant portion of this concern was presumably alleviated, and respondents reported a largely positive experience.

Further, while total levels of negative affect were slightly higher in a stream or meadow than from a platform, total levels of positive affect were slightly lower in a stream than a meadow or from a platform. This lower level of positive affect may have been a result of the focal bears being partially obscured by water, the orientation or movement of bears displayed in the videos, or unfamiliarity among respondents with bears in a stream setting.

As expected, respondents who viewed increasingly aggressive behaviors, reported lower levels of positive affect and higher levels of negative affect. This trend suggests respondents were largely able to correctly identify the behaviors presented. The fact that alertness and attentiveness were higher following aggressive behavior than curious or feeding behavior highlights a limitation of the PANAS scale. While these items are technically listed among positive affect, they may have been operationalized among respondents as more neutral, or even negative. For example, being alert and attentive is an expected human response to aggressive behaviors from bears and could be perceived

negatively. As a result, analysis of the PANAS scale has been primarily conducted at the item level, rather than the factor level.

It is important to note as well, that the total negative affect score for even the feeding behavior was higher than all but one among setting treatments. This could have been a result of seasonal differences between video series or other nuisance variables but could also have been in response to subtle defensive behaviors illustrated by the focal bear, such as burying or guarding the food source.

Behavioral responses

Objective appropriateness

Objective appropriateness for the 15 listed actions were determined using recommendations outlined by Herrero (2018) and Masterson (2016) and incorporated into Table 2.8. Those listed as “Inappropriate” are not recommended in any scenario because they could result in personal injury, could teach the bear bad habits, or would simply not be effective. Those listed as “Appropriate” are recommended across all scenarios. The appropriateness of those listed as “Depends” can depend on several factors, but mainly the bear’s behavior and the species of bear.

Kicking or punching the bear is only appropriate when encountering a predatory black bear. If the black bear is attacking, the most appropriate response is to fight back. Playing dead is largely recommended as an appropriate behavior but only when encountering an aggressive brown bear. When being attacked by a black bear or encountering a curious brown bear, playing dead could be highly ineffective or could cause the bear to investigate further. Shouting or making noise is an appropriate and

effective method to avoid surprising a brown or black bear and is the best choice when encountering a black bear. However, when approached or attacked by a brown bear, loud noises could anger or threaten the bear. It is important to talk calmly to a curious or aggressive brown bear and remain silent if it begins to attack. Bear spray is generally recommended when encountering an aggressive animal of any species but must be used correctly. If deployed too early or aimed too high, the spray will dissipate before it hits the bear. It is important to remain calm, wait for the bear to come within thirty feet, and then deploy the spray in short bursts at a 45-degree angle towards the ground.

Standing still and waiting for the bear to move is an acceptable behavior when viewing the bear from a safe distance and in a non-threatening manner. Give the bear plenty of space and time to move out of the way prior to approaching. However, if the bear remains there, it could be guarding a food source or cubs and the best option would be to turn around find a new route. Throwing things at the bear is largely inappropriate, especially for a brown bear, but may occasionally be necessary when hazing a curious black bear. The best method is to remove any potential bear attractants prior to this point, but if a black bear does become overly curious or aggressive, this could discourage the bear from unwanted behaviors. Lastly, walking around the bear is generally an appropriate behavior but it is important to keep an eye on the bear and its behavior. This should only be done if there is plenty of room and visibility to avoid surprising or threatening the bear and getting lost.

Table 2.8. *Perceived and objective appropriateness of listed actions.*

Listed Action	Perceived Appropriateness *Mean (SD)*	Objective Appropriateness
Approach the bear	1.75 (1.6)	Inappropriate
Back away slowly	5.57 (1.6)	Appropriate
Climb a tree	2.99 (1.9)	Inappropriate
Kick or punch the bear	2.36 (1.9)	Depends
Group together	4.33 (2.0)	Appropriate
Play dead	3.89 (2.0)	Depends
Run away	2.87 (2.1)	Inappropriate
Shout or make noise	3.31 (2.2)	Depends
Shoot the bear	2.52 (2.1)	Inappropriate
Spray with bear spray	2.86 (2.1)	Depends
Stand still and wait	4.77 (1.8)	Depends
Throw food into the woods	3.27 (2.0)	Inappropriate
Throw things at the bear	2.18 (1.8)	Depends
Try to hide	4.09 (2.0)	Inappropriate
Walk around the bear	4.64 (2.1)	Depends

Note. Perceived appropriateness is based on average rating across all setting treatments. Ratings were on a 7-point Likert scale (1 = extremely inappropriate, 4 = neither appropriate nor inappropriate, 7 = extremely appropriate). Objective appropriateness was determined based on recommendations outlined by Herrero (2018) and Masterson (2016).

Likelihood and perceived appropriateness

The most directly applicable results of this study came from the difference between likelihood and perceived appropriateness of potential actions. In cases where likelihood exceeded appropriateness, individuals may have known the intended behavior could have resulted in injury, but were unable to overcome their emotional and affective responses to the bear encounter. Such scenarios included running away from a boar in a meadow, throwing things at a subadult in a meadow, and throwing food into the woods to lure a sow and cubs away from a platform. These three behaviors then, are areas of concern within bear safety and management. Public perception regarding these behaviors may prove difficult to overcome. In order to do so, efforts must be made to encourage

further internalization of not only the danger associated with these behaviors, but how to behave appropriately in such scenarios as well. All park visitors and area residents must fully understand the benefits of appropriate actions and the consequences of inappropriate actions.

When likelihood exceeded appropriateness, individuals were likely aware that their actions may not have been appropriate. However, when the opposite was true, individuals believed the behavior to be appropriate but were unable to act accordingly. In such cases, individuals may understand the importance of behaving in such a manner, but current emotional and affective state encourage behaving otherwise. Some of these behaviors were shooting a subadult in a meadow, backing away slowly or playing dead to avoid a sow and cubs in a stream, and backing away slowly when viewing a boar from a platform. Further, all seven significant differences among behavior treatments fall into this category as well. These include playing dead to avoid a feeding bear, climbing a tree, playing dead, waiting for the bear to leave, or walking around the bear to avoid a curious bear, and climbing a tree or walking around the bear to avoid an aggressive bear.

Similar to inappropriate behaviors in the former category, behaviors in this latter category that were appropriate, such as backing away slowly or walking around a sow and cubs in a stream, require management and safety instruction to emphasize the benefits to such behavior and the reasoning behind its effectiveness. Experiential training through photographs, videos, or virtual reality could help park visitors and area residents to imagine such scenarios and practice behaving appropriately, weakening these affective shortcuts. If needed, examples of worst-case scenarios may provide a significant

reminder of potential consequences. Most likely due to the novelty of the experience, viewing a sow and cubs in a stream resulted in the most behaviors in this category and as a result, requires additional attention.

An additional area of concern is the fact that several actions in this latter category could be inappropriate or dangerous (Herrero 2018). Climbing a tree, responding aggressively (i.e., shooting the bear or throwing things at the bear), throwing food to lure the bear away, and running away are all seen among the general American public as appropriate but are rarely so, and could result in injury or death to either party. According to survey results, these actions were more appropriate than likely, making them not yet problematic, as respondents were generally less likely to behave in such a way. In order to prevent these actions from becoming a problem, managers and staff must continue to reinforce the inappropriateness of these actions, explaining the specific factors leading to their inefficacy.

Management implications

From these results and further suggestions provided by respondents, I developed 8 recommendations to improve the overall effectiveness of safety training and education efforts regarding brown bears.

1. All bear safety education should warn of potential affective responses such as fear, hostility, and attentiveness that may occur during an encounter and remind users to remain calm.

2. Education efforts should continue to address the appropriateness of uncertain or popular behaviors, including climbing a tree, running away, trying to hide, grouping together, and walking around the bear.
3. Regions with established brown bear populations, as well as those on the edge of dispersing populations, should release bear safety public service announcements across several forms of media to reach the widest audience possible.
4. Place educational materials (e.g., signs, pamphlets, interactive displays, etc.) at various locations outside of park visitor's centers.
5. Use photographs, videos, and virtual reality experiences to incorporate various scenarios and bear behaviors in preparing users for potential bear encounters
6. Provide logic and reasoning behind policies, regulations, and behavioral instructions, including potential negative results.
7. Pay special attention to overly confident individuals, those with more experience, and those more likely to respond aggressively, particularly younger males.
8. If necessary and feasible, mandatory bear safety training prior to park admission may be an effective solution. If not, consider implementing a mandatory bear safety lesson or video prior to purchasing park passes online.

Limitations

Threats to internal validity

While the PANAS scale has been well tested and items were chosen to best reflect the viewing experience, its use and abbreviation only approximates the range of potential affective responses. A representative sample was collected with adequate sample size, but Qualtrics users and those willing to take the survey may not be entirely representative of the general American public, or those visiting national parks or other protected areas where bear viewing may occur. Although statistically accounted for by appropriate analysis, the repeated use of scales within the survey may have resulted in a testing effect, or dependency between measures.

Threats to external validity

For feasibility, survey respondents were provided with videos representing each scenario as opposed to firsthand experience. As a result, affective responses may have been limited or dulled. The online survey format also allowed respondents to pause and reflect prior to answering and potentially select answers believed to be correct rather than true. Lastly, despite significant effort to minimize nuisance variables among videos, some were unavoidable and may have unintentionally altered affective responses.

Future research

Research on emotional reactions to viewing wildlife, especially carnivores, has been limited in scope. Many previous studies have addressed feelings towards carnivores (e.g., Farber & Hall, 2007; Jacobs, Fehres, & Campbell, 2012; Jacobs, Vaske, & Roemer, 2012; Raadik & Cottrell, 2007) or opinions regarding potential management action (e.g.,

Gilkman, Vaske, Bath, Ciucci, & Boitani, 2012; Hayman, Harvey, Mazzotti, Israel, & Woodward, 2014; Johansson, Sjostrom, Karlsson, & Brannlund, 2012; McFarlane, Stumpf-Allen, & Watson, 2007), but the focus on how these reactions impact behavior is currently understudied. This study begins to address the current knowledge gap, but more importantly, provides a foundation for continued exploration. Future research could use participant observations and onsite qualitative interviews to further understand complex emotional responses beyond what quantitative questionnaires allow. It is also important to test the applicability of virtual reality technology in representing onsite encounters. While still more contrived than firsthand experience, this developing technology could allow park managers and bear safety administrators to accurately represent different scenarios and encourage appropriate behavior despite affective responses. Further research in virtual reality could also be used to advance visual methods within park and visitor management research.

An additional area of interest is the applicability of this research to other settings or wildlife species. Videos and questions included in this survey were targeted at brown bears, but behavioral similarities and misidentification suggest results may be highly transferable to black bears. Future research efforts should assess this degree of transferability to not only black bears, but entirely different contexts as well, such as African safaris, tiger viewing in India, underwater at coral reefs, or even deer hunting. Although it would need to be tested, I anticipate similar results across contexts. Potential hypotheses and predictions to test include:

H_1: Overall levels of positive and negative affect differ across contexts

P_1: More unique or rarer scenarios result in higher levels of overall positive affect

P_2: More dangerous scenarios result in higher levels of overall negative affect

H_2: Levels of positive and negative affect respond differently across scenarios

P_1: All scenarios produce a similar level of positive affect

P_2: More dangerous scenarios produce higher levels of negative affect

Conclusion

Not only do affective responses differ across various bear encounter scenarios, these affective responses can potentially discourage appropriate behavior while encouraging inappropriate behavior. Scenarios that produce intense affective responses are often the most dangerous, but significantly increase the impact of emotion on decision-making. Managers of relevant parks and protected areas must continue to educate visitors on safe behavior around bears while further detailing the reasoning and logic behind policies and encouraged behaviors. While rarely feasible, the ideal solution would be to conduct mandatory training sessions at all relevant parks and protected areas prior to admission, including further emphasis on appropriate behavior. Survey respondents also suggested public service announcements, further online training or information regarding safe behavior, video and virtual reality practice encounters, education on understanding bear behavior, and cautionary tales, as potential methods to encourage appropriate behavior; all of which could provide feasible and effective improvements to bear safety education.

Acknowledgements

I would like to thank YouTube users GroundTruthTrekking and Photoguide for the videos used in the behavior treatments.

Literature Cited

Aumiller, L. D. and C.A. Matt. 1994. Management of McNeil river state game sanctuary for viewing of brown bears. *Bears: Their Biology and Management* 9:51-61.

Bateson, J. E. G. and M.K. Hui. 1992. The ecological validity of photographic slides and videotapes in simulating the service setting. *Journal of Consumer Research* 19(2):271-281.

Byrne, B. M. 2008. Testing for multiple equivalence of a measuring instrument: a walk through the process. *Psicothema* 20(4):872-882.

Cabrera, N. L. 2011. Using a sequential exploratory mixed-method design to examine racial hyperprivilege in higher education. *New Directions for Institutional Research* 2011(151): 77-91.

Crawford, J. R., and J.D. Henry. 2004. The positive and negative affect schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology* 43(3):245-265.

Crocker, P. R. E. 1997. Confirmatory factor analysis of the PANAS with a youth sport sample. *Journal of Sport & Exercise Psychology* (19):91-97.

Dillman, D. A. 2011. *Mail and internet surveys: the tailored design method: 2007 update with new internet, visual, and mixed-mode guide*. Second edition. John Wiley and Sons. Hoboken, NJ, USA.

Ekkekakis, P. 2012. Affect, mood, and emotion. Pages 321–332 *in Measurement in Sport and Exercise Psychology*. Human Kinetics. Champaign, IL, USA.

Farber, M. E. and T. E. Hall. 2007. Emotion and environment: visitors' extraordinary experiences along the Dalton Highway in Alaska. *Journal of Leisure Research* 39(2):248-270.

Freimund, W. A., J. J. Vaske, M. P. Donnelly, and T. A. Miller. 2002. Using video surveys to access dispersed backcountry visitors' norms. *Leisure Sciences* 24(3-4):349-362.

Glikman, J. A., Vaske, J. J., Bath, A. J., Ciucci, P., & Boitani, L. 2012. Residents' support for wolf and bear conservation: The moderating influence of knowledge. *European Journal of Wildlife Research* 58(1): 295-302.

Gunther, K.A. and H.E. Hoekstra. 1998. Bear-inflicted human injuries in Yellowstone National Park, 1970-1994. *Ursus* 10:377-384.

Halcomb, E. J. and P. M. Davidson. 2006. Is verbatim transcription of interview data always necessary? *Applied Nursing Research* 19(1):38-42.

Haroldson, M. A. and K. A. Gunther. 2013. Roadside bear viewing opportunities in Yellowstone National Park: characteristics, trends, and influence of whitebark pine. *Ursus* 24(1):27-41.

Hayman, R. B., Harvey, R. G., Mazzotti, F. J., Israel, G. D., & Woodward, A. R. 2014. Who complains about alligators? cognitive and situational factors influence behavior toward wildlife. *Human Dimensions of Wildlife* 19(6): 481-497.

Herrero, S. 1976. Conflicts between man and grizzly bears in the national parks of North America. *Bears: Their Biology and Management* 3:121–145.

Herrero, S. 2018. *Bear attacks: their causes and avoidance*. Third edition. Lyons Press. Guilford, CT, USA.

Jacobs, M. H., Vaske, J. J., & Roemer, J. M. 2012. Toward a mental systems approach to human relationships with wildlife: The role of emotional dispositions. *Human Dimensions of Wildlife* 17(1): 4-15.

Jacobs, M. H., P. Fehres, and M. Campbell. 2012. Measuring emotions toward wildlife: A review of generic methods and instruments. *Human Dimensions of Wildlife* 17(4):233-247.

Jochum, K. A., A. A. Kliskey, K. J. Hundertmark, and L. Alessa. 2014. Integrating complexity in the management of human-wildlife encounters. *Global Environmental Change* 26(1):73-86.

Johansson, M., Sjöström, M., Karlsson, J., & Brännlund, R. 2012. Is human fear affecting public willingness to pay for the management and conservation of large carnivores? *Society & Natural Resources* 25(6): 610-620.

Kahneman, D. and A. Tversky. 1973. On the psychology of prediction. *Psychological Review* 80(4):237-251.

Kline, R. B. 2012. Assumptions in structural equation modeling. Pages 111–125 *in* R. H. Hoyle, editor. *Handbook of structural equation modeling*. Guilford Press. New York, NY, USA.

Laven, D.N. and D.H. Krymkowski. 2005. The relationship between visitor-based standards of quality and existing conditions in parks and outdoor recreation. *Leisure Sciences* 27(2):157-173.

Manning, R.E., W.A. Valliere, and B. Wang. 1999. Crowding norms: alternative measurement approaches. *Leisure Sciences* 21(2):97-115.

Manning, R.E. and W.A. Freimund. 2004. Use of visual research methods to measure standards of quality for parks and outdoor recreation. *Journal of Leisure Research* 36(4):557-579.

Masterson, L. 2016. *Living with bears handbook.* Second edition. PixyJack Press, Inc., Masonville, Colorado, USA.

McFarlane, B. L., Stumpf-Allen, R., & Watson, D. O. T. 2007. Public acceptance of access restrictions to grizzly bear (ursus arctos) country. *Human Dimensions of Wildlife* 12(4): 275-287.

Newman, P., J.L. Marion, and K. Cahill. 2001. Integrating resource, social, and managerial indicators of quality into carrying capacity decision-making. *The George Wright Forum* 18(3):28-40.

Quartz, S. R. 2009. Reason, emotion and decision-making: Risk and reward computation with feeling. *Trend in Cognitive Sciences* 13(5):209-215.

Raadik, J., & Cottrell, S. 2007. Wildlife value orientations: An Estonian case study. *Human Dimensions of Wildlife* 12(5): 347-357.

Schmukle, S. C., B. Egloff, and L.R. Burns. 2002. The relationship between positive and negative affect in the positive and negative affect schedule. *Journal of Research in Personality* 36:463-475.

Seidman, I. 2012. *Interviewing as qualitative research: a guide for researchers in education and the social sciences*. Teachers College Press. New York, NY, USA.

Slovic, P., E. Peters, M. L. Finucane, and D. G. MacGregor. 2005. Affect, risk, and decision making. *Health Psychology* 24(4S):S40.

Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *Journal of Cross-Cultural Psychology* 38(2):227-242.

Tversky, A. and D. Kahneman. 1973. Availability: A heuristic for judging frequency and probability. *Cognitive Psychology* 5:207-232.

U.S. Census Bureau (USCB). 2020. ACS demographic and housing estimates. Retrieved from https://data.census.gov/cedsci/table?q=demographics&hidePreview=false&tid=ACSDP1Y2018.DP05&vintage=2018.

Vaske, J. J. 2008. *Survey research and analysis: Applications in parks, recreation, and human dimensions.* Venture Publishing Inc. State College, PA, USA.

Watson, D., L. A. Clark, and A. Tellegen. 1988. Development and validation of brief measures of positive and negative affect. *Journal of Personality and Social Psychology* 54(6):1063-1070.

Wilson, R. S. 2008. Balancing emotion and cognition: A case for decision aiding in conservation efforts. *Conservation Biology* 22(6):1452-1460.

CHAPTER THREE

A NATIONAL ASSESSMENT OF KNOWLEDGE REGARDING BEAR SAFETY AND APPROPRIATE BEHAVIOR

Introduction

At the end of the year 2019, nearly 7.8 billion humans inhabited the earth (UN 2020). This number is expected to approach 10 billion within the next 30 years as population growth begins to slow (Cohen 2003). Protected areas across the globe attract human settlement and economic development to rural areas (Wittemyer et al. 2008). Increasing human presence and development along with increasing appreciation for nature-based recreation among Americans (Cordell, Betz, and Green 2008, Cordell and Tarrant 2002) poses a significant threat to the wild lands originally intended for preservation. Outdoor recreation and higher levels of human use can result in stress, fleeing, and population decline for many wildlife species, including brown bears (Nevin and Gilbert 2005), desert bighorn sheep (Papouchis, Singer, and Sloan 2001) and North American wood turtles (Garber and Burger 1995). However, the impact of these changes depends on more than just the amount of use. Human behavior largely decides humans' ability to coexist with the environment and cope with new ecological challenges that arise (Goujon 2018).

Despite continued human population growth, populations of grizzly bears (*Ursus arctos*) have begun to recover throughout both the Northern Continental Divide Ecosystem (NCDE) and the Greater Yellowstone Ecosystem (GYE) (Bjornlie et al. 2014, Costello et al. 2016, Eberhardt and Breiwick 2010, Haroldson et al. 2016, Keating 1986,

Kendal et al. 2009, Mace et al. 2012, Schwartz et al. 2006). However, many still worry of the limited genetic and landscape connectivity between these populations, restricting their long term success and resilience (Haroldson et al. 2010, Peck et al. 2017, Proctor et al. 2015, Schwartz, Haroldson, and White 2010, Shafer 2015,). The significant, negative impacts of human-dominated landscapes, such as habitat fragmentation and incidental take, on population recovery and expansion have been well documented (e.g., Proctor et al. 2015, Pyare et al. 2004, Schwartz, Haroldson, and White 2010, Shafer 2015). In order for continued recovery, these threats must be addressed.

With expanding populations of both humans and brown bears, interactions between species are bound to occur. These interactions, however, often result in trapping, relocating, or euthanizing the bear (Wilson, Neudecker, and Jonkel 2014). Unfortunately, while many of these incidents are easily preventable through proper human behavior, even one mistake could produce multiple generations of problem bears (Aumiller and Matt 1994, Masterson 2016, Morehouse et al. 2016). Not only are residents within brown bear habitat responsible for behaving properly, but large numbers of tourists and park visitors must as well. To address this area of concern, I conducted an online self-assessment survey to test the bear safety knowledge of the general American public when presented with several brown bear encounter scenarios. Specific research questions included:

1) What locations have resulted in the most brown bear sightings among respondents?
2) How accurate are respondents at identifying brown bears?

3) How do respondents view their level of bear safety knowledge?
4) What factors contribute to a respondent's perceived appropriateness of potential actions?

Study population

I distributed an online survey to a sample of the general American public through a cross-sectional representative sample study purchased from online survey platform, Qualtrics. Unless bear safety training is mandatory and standardized, many visitors and residents may encounter a brown bear without having knowledge of proper behavior. I chose the general American public as the study population to best understand how such individuals will behave in bear encounter scenarios, with or without previous training. Purchasing a cross-sectional representative sample allowed for efficient data collection given the broad sampling population. Qualtrics sampling procedures used six demographic questions and standard U.S. Census Bureau categories as qualifiers to ensure a representative sample. These included age, education level, gender, income, race, and zip code of primary residence.

Methods

Study design

I developed an online self-assessment survey of bear safety knowledge among the general American public. This study employed two independent samples designs: a 3x3 design as well as an additional 3x1 design. The first design (3x3), setting treatment, compared perceived appropriateness of potential actions across three different settings and three different sex or age classes. Settings included a salmon stream, a meadow, and

a viewing platform while age and sex classes included a solitary boar, a sow with cubs, and a subadult. While brown bear encounters can occur in other settings, the three included here represent the most common viewing scenarios across the United States and two distinctly different feeding behaviors (i.e., fishing and grazing). Study design 2 (3x1), behavior treatment, acted as a qualifier, testing perceived appropriateness of potential actions across bear behavior, holding the setting and sex or age class constant. The three studied behaviors were feeding, curious, and aggressive, but respondents were not provided with an interpretation or description. Behavior was held constant across the entire 3x3 design but was tested here to alleviate the threat to external validity resulting from the lack of independence between bear behavior and an individual's response. This second design also served as an additional test of current education efforts and an individual's ability to behave appropriately in such situations.

Treatment videos

To best simulate the nine setting treatments, I captured high quality video clips at Katmai and Lake Clark National Parks that effectively demonstrated the intended scenario while minimizing any nuisance variables due to unintended differences across videos, such as lighting, weather, microhabitat, size and positioning of the bear, and video quality. These locations support abundant brown bear populations while providing high quality viewing experiences in all three of the intended settings. For the three behavior treatments, I elicited videos from online bear-viewing communities, online video sharing sites, and public access documentaries. Videos were selected that displayed only the focal bear and clearly illustrated intended behavior, while minimizing

differences due to microhabitat, lighting, weather, age or sex of the bear, and video quality. All final videos are available online (http://tinyurl.com/Affect-Videos).

Researchers in visitor use management often use visual methods, in the form of computer-altered photographs, to help identify outdoor recreationists' ideal conditions (Laven and Krymkowski 2005, Manning, Valliere, and Wang 1999). Photographs depicting varying levels of resource or experiential impact can be used as suggestive surrogates for true conditions (Newman, Marion, and Cahill 2001) and are much more effective than traditional narrative descriptions (Manning and Freimund 2004). While less studied, videos have also been used successfully to determine park visitors' preferred conditions (Bateson and Hui 1992, Freimund et al. 2002).

This study would have ideally been conducted in person, but field research would not have allowed the questions to be addressed. Not only would this method be time consuming and expensive, it would be difficult to maintain consistency across scenarios and ensure all types of encounters were represented. As a result, videos were used to best depict first-hand experience of bear behavior and viewing locations, allowing me to design the experiment appropriately while keeping both bears and humans safe and avoiding distractions during onsite experiences. Further research could test the potential of virtual reality in more accurately depicting encounter scenarios or could use an in person qualitative approach to assess emotional reactions on a deeper level immediately following an encounter. This research could occur at several different parks and protected areas to assess reactions to various types of bear viewing scenarios using participant observation.

Quantitative questionnaire

I developed the questionnaire through an online survey platform, Qualtrics, using best practices for online survey construction as described by Dillman (2011) and Vaske (2008). Questionnaires showed each respondent a randomly selected video from each treatment group (i.e., setting and behavior). For each video, respondents were asked to rate the appropriateness of fifteen potential actions on a seven-point Likert scale (1 = extremely inappropriate, 7 = extremely likely or appropriate). For this question, respondents were given the additional option to select "I don't know" for each action. These potential actions were chosen based on historical accounts of reactions discussed by Gunther and Hoekstra (1998) and Herrero (2018) and personal accounts from working in bear safety education. The final list was chosen to provide a range of appropriateness and was listed in alphabetical order.

Prior to each video, I included a photograph of the viewing scenario and explicit instructions to encourage respondents to immerse themselves in the video and respond based only on immediate reactions to each video. Figure 3.1 displays the photographs for each setting category (i.e., meadow, stream, and platform). This figure also includes the generic bear viewing photo displayed prior to all three behavior treatments used to further illustrate the viewing scenario.

Bear identification

At the beginning of the survey, I provided brief descriptions about the differences between brown and black (*Ursus americanus*) bears and the relationship between brown and grizzly bears. This was followed by a range map for the three North American bear

species. Respondents were then asked to select the brown bears out of six bear pictures. Two were black bears, two were brown bears, one was a polar bear (*Ursus maritimus*), and one was a giant panda (*Ailuropoda melanoleuca*).

Figure 3.1. Images shown to respondents prior to viewing the respective setting and behavior treatment videos.

Self-reported knowledge of bear safety.

Regardless of a respondent's previous experience with any bear species or bear safety education, I asked them to grade themselves on their ability to behave safely around bears using a thirteen-point scale with standard letter grades from A+ to F.

Respondents with bear safety experience were also asked the source of their bear safety information (e.g., commercial guide, taught themselves, park or destination staff, etc.)

Analysis

All statistical analyses were conducted using IBM's Statistics Package for the Social Sciences (SPSS) version 24.0 (2018). I used descriptive statistics, measures of central tendency, general linear models, and when necessary, Bonferroni post-hoc tests to analyze results.

To understand the factors that determine the appropriateness of behaviors I ran a univariate general linear model for each potential action with six categorical and four continuous explanatory variables. These ten variables were determined prior to analysis and were included in all models. In all cases, the model was statistically significant ($p < 0.01$) but explained relatively little of the variation in the data. These models were included to highlight potential sources of variation between individuals but are not to be used to make predictions.

Results

I received a total of 511 complete responses with approximately 57 responses ($SD = 4.39$) for each of nine setting treatments and 170 responses ($SD = 7.76$) for each of three behavior treatments. For all sample-wide analyses, this produced an overall confidence interval of 4.34% at the 95% confidence level, suggesting a high-quality sample. To confirm that the sample produced enough statistical power to detect differences in means, I calculated the minimum sample size per cell needed to maintain a power of 0.8. Since statistical power decreases with further segmentation, I determined

the minimum sample size required for each of 12 cells across both study designs (i.e., setting and behavior treatments) If the true effect size was 0.2, each cell would require a sample size of 36 to produce a power of 0.8 at a significance level of 0.05. If the true effect size was 0.15, each cell would require a sample size of 63. Based on the average observed sample size per cell (n = 57), an effect size of 0.15, and a significance level of 0.05, the resulting statistical power was 0.66. As a result, I am confident in the sample's ability to detect even minor differences in means.

The sample accurately represented the general American public, as estimated by the U.S. Census Bureau (USCB, 2020), with 66.5% identifying as white, 16.6% as Hispanic or Latino/Latina, 18.4% earning less the $24,999 per year, 17.8% earning between $50,000 and $74,999, 14.9% earning between $25,000 and $49,999, 24.1% reporting high school graduate as their highest level of education, 24.1% reporting a four-year college degree as their highest level of education, and 45% identifying as female.

Experience viewing brown bears

Of all questionnaire respondents, 55% had never seen a wild brown bear, while 11.2% had seen a wild bear but were unsure of the species (Figure 3.2). When asked to select the region within the lower 48 states in which they had seen a brown (grizzly) bear, many individuals either selected viable regions with no confirmed population (i.e., North Cascades and Bitterroot Regions) or chose to write in additional areas such as Colorado, California, or Tennessee (Table 3.1) that currently have no potential for brown bear sightings.

Figure 3.2. Responses to questions regarding an individual's past experience viewing brown bears.

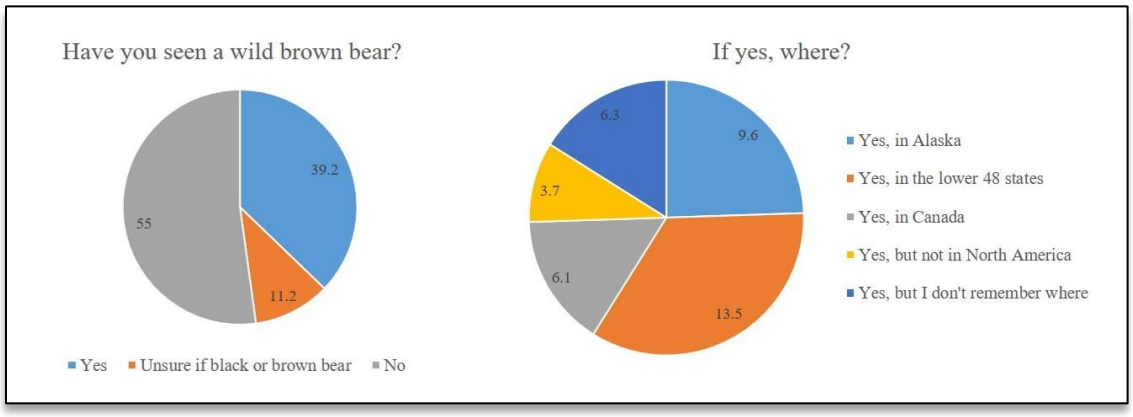


Table 3.1. *Locations in which respondents report viewing a wild brown (grizzly) bear within the lower 48 states.*

Location	Frequency	Percent
Greater Yellowstone Region	28	40.6
North Cascades Region[a]	19	27.5
Northern Continental Divide Region	17	24.6
Bitterroot Region[a]	14	20.3
None of these	9	13.0
Colorado[b]	4	5.8
Selkirk Region	3	4.4
Cabinet-Yaak Region	3	4.4
California[b]	3	4.4
Tennessee[b]	3	4.4
Pennsylvania[b]	2	2.9
Michigan[b]	2	2.9

Note. [a]Within the U.S. Fish and Wildlife Service recovery zone but currently no confirmed population, [b]No populations of brown (grizzly) bears.

Bear identification

After a brief lesson on bear identification, respondents were asked to select the brown (grizzly) bears out of six bear pictures. Two were black bears, two were brown bears, one was a polar bear, and one was a giant panda (Figure 3.3). Only 18.6% of respondents were able to correctly select both photos while 9.1% selected more incorrect

photos than correct photos. A large majority of the sample (93.2%) was able to correctly select one of the brown bear photos, but only 42.5% correctly selected the second of two brown bear photos. While the videos, questionnaire, and analyses were specific to brown bears, this propensity for misidentification suggests visitors may not respond any differently to black bears. This is slightly concerning in that encounters with black and brown bears occasionally require different behavior. Even individuals provided with information on the two species struggled in identification, emphasizing the need for further elaboration in this topic during bear safety instruction.

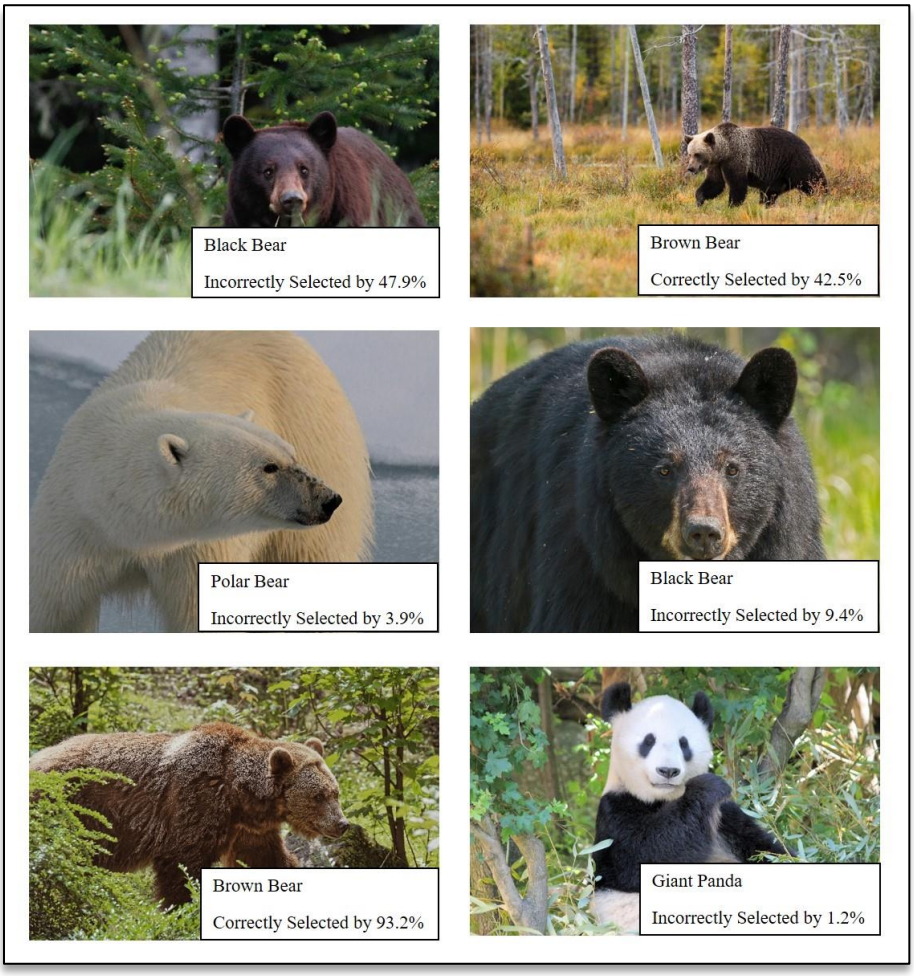


Figure 3.3. Images shown to respondents to assess accuracy in identifying bear species, with the percent of sample selecting each image. Respondents were asked to select all brown bears.

Self-reported knowledge of bear safety

In addition, while 75% had never participated in an official bear safety training, only 47.2% had never received any bear safety instruction (Figure 3.4, Table 3.2). Individuals who taught themselves reported slightly higher grades (M = 9.69; B+, SD = 2.8) than those who learned from other sources, but all were significantly higher ($p < 0.05$) than those who had not been taught (M = 5.82; C, SD = 3.5) (Table 3.3). However, it is important to not that these grades are self-reported, so a slightly higher grade among those who taught themselves does not necessarily mean this group is more knowledgeable, just that they describe themselves as such.

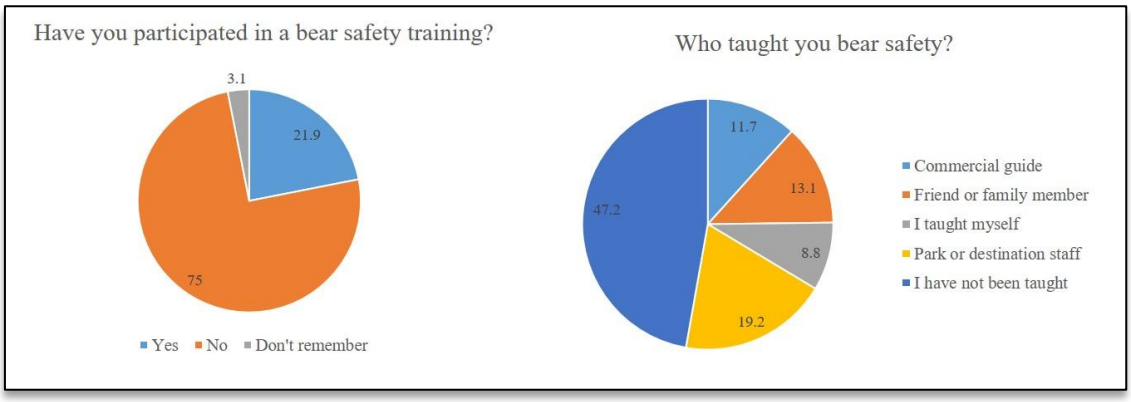


Figure 3.4. Responses to questions regarding an individual's past experience with bear safety education.

Table 3.2. *Respondents' self-reported grades for knowledge of safe behavior around bears.*

GRADE	FREQUENCY	PERCENT
A+	72	14.1
A	26	5.1
A-	18	3.5
B+	51	10.0
B	46	9.0
B-	56	11.0
C+	56	11.0
C	56	11.0
C-	34	6.7
D+	22	4.3
D	14	2.7
D-	12	2.3
F	48	9.4

Table 3.3. *Respondents' self-reported grades for knowledge of safe behavior around bears, split by source of bear safety education.*

Source	Mean	SD	Grade
Commercial guide	9.25A	3.2	B
Friend or family member	9.33A	3.1	B
I taught myself	9.69A	2.8	B+
Park or destination staff	9.17A	2.6	B
I have not been taught	5.82B	3.5	C

Note. Capped Roman letters in Mean column represent statistically significant differences among means ($p < 0.05$). Grade was on a thirteen-point scale using standard letter grades from F to A+.

Objective appropriateness of actions

Objective appropriateness for the 15 listed actions were determined using recommendations outlined by Herrero (2018) and Masterson (2016) and incorporated into Table 3.4. Those listed as “Inappropriate” are not recommended in any scenario because they could result in personal injury, could teach the bear bad habits, or would simply not be effective. Those listed as “Appropriate” are recommended across all scenarios. The appropriateness of those listed as “Depends” can depend on several factors, but mainly the bear’s behavior and the species of bear.

Kicking or punching the bear is only appropriate when encountering a predatory black bear. If the black bear is attacking, the most appropriate response is to fight back. Playing dead is largely recommended as an appropriate behavior but only when encountering an aggressive brown bear. When being attacked by a black bear or encountering a curious brown bear, playing dead could be highly ineffective or could cause the bear to investigate further. Shouting or making noise is an appropriate and effective method to avoid surprising a brown or black bear and is the best choice when encountering a black bear. However, when approached or attacked by a brown bear, loud noises could anger or threaten the bear. It is important to talk calmly to a curious or aggressive brown bear and remain silent if it begins to attack. Bear spray is generally recommended when encountering an aggressive animal of any species but must be used correctly. If deployed too early or aimed too high, the spray will dissipate before it hits the bear. It is important to remain calm, wait for the bear to come within thirty feet, and then deploy the spray in short bursts at a 45-degree angle towards the ground.

Standing still and waiting for the bear to move is an acceptable behavior when viewing the bear from a safe distance and in a non-threatening manner. Give the bear plenty of space and time to move out of the way prior to approaching. However, if the bear remains there, it could be guarding a food source or cubs and the best option would be to turn around find a new route. Throwing things at the bear is largely inappropriate, especially for a brown bear, but may occasionally be necessary when hazing a curious black bear. The best method is to remove any potential bear attractants prior to this point, but if a black bear does become overly curious or aggressive, this could discourage the bear from unwanted behaviors. Lastly, walking around the bear is generally an appropriate behavior but it is important to keep an eye on the bear and its behavior. This should only be done if there is plenty of room and visibility to avoid surprising or threatening the bear and getting lost.

Table 3.4. *Perceived and objective appropriateness of listed actions.*

Listed Action	Perceived Appropriateness *Mean (SD)*	Objective Appropriateness
Approach the bear	1.75 (1.6)	Inappropriate
Back away slowly	5.57 (1.6)	Appropriate
Climb a tree	2.99 (1.9)	Inappropriate
Kick or punch the bear	2.36 (1.9)	Depends
Group together	4.33 (2.0)	Appropriate
Play dead	3.89 (2.0)	Depends
Run away	2.87 (2.1)	Inappropriate
Shout or make noise	3.31 (2.2)	Depends
Shoot the bear	2.52 (2.1)	Inappropriate
Spray with bear spray	2.86 (2.1)	Depends
Stand still and wait	4.77 (1.8)	Depends
Throw food into the woods	3.27 (2.0)	Inappropriate
Throw things at the bear	2.18 (1.8)	Depends
Try to hide	4.09 (2.0)	Inappropriate
Walk around the bear	4.64 (2.1)	Depends

Note. Perceived appropriateness is based on average rating across all setting treatments. Ratings were on a 7-point Likert scale (1 = extremely inappropriate, 4 = neither appropriate nor inappropriate, 7 = extremely appropriate). Objective appropriateness was determined based on recommendations outlined by Herrero (2018) and Masterson (2016).

Factors in perceived appropriateness of actions

Respondent age and who taught bear safety were both significant for eleven of the fifteen potential behaviors while attending a bear safety training and reported bear safety grade were only significant for one and two behaviors, respectively.

Males reported statistically higher levels of appropriateness for fight or flight behaviors, such as kicking or punching the bear, $F(2, 995) = 7.69$, $p < 0.001$, shooting the bear, $F(2, 995) = 15.61$, $p < 0.001$, or running away, $F(2, 995) = 5.67$, $p = 0.004$, than did females (Table 3.5). Additionally, older individuals classified a majority of the listed actions as less appropriate than did younger individuals (Table 3.5), such as climbing a tree, $F(1, 995) = 19.77$, $p < 0.001$, hiding, $F(1, 995) = 19.83$, $p < 0.001$, throwing things at the bear, $F(1, 995) = 30.32$, $p < 0.001$, or approaching the bear, $F(1, 995) = 37.50$, $p < 0.001$.

Further, those who had seen a wild brown bear viewed backing away slowly, $F(1, 995) = 7.20$, $p = 0.009$, or grouping together, $F(1, 995) = 4.15$, $p = 0.042$, as less appropriate and kicking or punching the bear, $F(1, 995) = 4.35$, $p = 0.037$, or throwing things at the bear, $F(1, 995) = 8.95$, $p = 0.003$, as more appropriate than those who had not (Table 3.5). Lastly, individuals reporting higher bear safety grades saw approaching the bear, $F(1, 995) = 459$, $p = 0.032$, and running away, $F(1, 995) = 7.63$, $p = 0.006$, both as more appropriate than did individuals reporting lower bear safety grades (Table 3.5).

For the effect of video treatment in these models, (i.e., which of the twelve potential videos the individual was responding to), shouting or making noise, $F(11, 995) = 2.39$, $p = 0.026$, shooting the bear, $F(11, 995) = 3.62$, $p < 0.001$, and spraying bear

spray, $F(11, 995) = 2.41$, $p = 0.026$, were all significantly more appropriate for an aggressive bear than a feeding bear (Table 3.6). In addition, throwing things at the bear was significantly more appropriate when encountering a curious bear than encountering a boar in a stream, $F(11, 995) = 2.42$, $p = 0.026$ (Table 3.6). Further, those who live in states with black bears only viewed standing still and waiting for the bear to leave as significantly more appropriate than did those who live in states with no bears or both black and brown bears, $F(2, 995) = 11.71$, $p < 0.001$ (Table 3.7).

For the effect of the source of bear safety information in these models, those taught by park or destination staff report the statistically lowest levels of appropriateness for all eleven models in which it was significant, $F(4, 995) > 2.38$, $p < 0.05$. Of these eleven actions, six are categorized as inappropriate, four as depends, and one as appropriate. Individuals taught by a commercial guide or who taught themselves generally reported the highest levels of appropriateness, $F(4, 995) > 2.38$, $p < 0.05$ (Table 3.8). There were also four activities that respondents were largely uncertain about; climbing a tree, grouping together to appear larger, standing still and waiting for the bear to leave, trying to hide, and walking around the bear, with approximately 17.9%, 21.9%, 25.7%, 20.4%, and 26.0%, respectively, unsure of the appropriateness of such behavior (Figure 3.5). These topics are potential areas to address during bear safety education efforts.

Table 3.5. *Resulting F values from univariate general linear models for appropriateness of listed actions.*

	Corrected Model	Intercept	Video treatment	Bears where you live	Ever seen a bear	Feelings towards bears	Attended a safety training	Who taught bear safety	Bear safety grade	Gender	Age	Education	Adjusted R^2
Action	$F(26, 995)$	$F(1, 995)$	$F(11, 995)$	$F(2, 995)$	$F(1, 995)$		$F(2, 995)$	$F(4, 995)$	$F(1, 995)$	$F(2, 995)$	$F(1, 995)$		
Approach the bear	7.2**	46.5**	1.2	0.7	2.9	0.9	0.8	9.3**	4.6*	6.7**	37.5**	0.9	0.14
Back away slowly	2.6**	125.4**	2.5**	4.7**	7.2**	6.2*	0.5	0.5	0.0	0.7	4.6*	2.8	0.04
Climb a tree	3.4**	67.9**	1.3	0.4	0.7	1.7	1.4	4.2**	1.8	0.0	19.8**	1.4	0.06
Kick or punch the bear	5.1**	54.8**	2.0*	0.6	4.3*	0.1	3.6*	5.7**	2.6	7.7**	17.2**	1.7	0.10
Group together	2.1**	89.1**	2.0*	1.0	4.1*	2.1	0.7	2.6*	1.2	0.5	9.4**	0.3	0.03
Play dead	2.0**	112.2**	1.0	0.7	0.0	0.0	0.3	2.0	1.5	2.8	5.1*	2.5	0.02
Run away	4.1**	58.1**	1.4	0.2	3.3	0.2	0.7	3.0*	7.6**	5.7**	33.1**	1.5	0.07
Shout or make noise	3.1**	47.0**	2.4**	2.7	1.0	0.2	1.0	5.8**	1.3	1.8	0.3	0.1	0.05
Shoot the bear	5.3**	84.8**	3.6**	2.4	0.4	4.9*	2.6	4.2**	1.8	15.6**	12.3**	4.8*	0.10
Spray with bear spray	3.5**	63.1**	2.4**	0.9	0.2	0.1	2.0	3.7**	1.3	10.4**	3.3	2.3	0.06
Stand still and wait	1.9**	109.7**	1.0	11.7**	2.0	1.7	1.5	0.3	2.5	2.0	0.8	1.7	0.02
Throw food into woods	2.4**	65.4**	1.4	3.4*	2.2	0.3	0.7	2.6*	0.0	1.8	13.5**	2.7	0.04
Throw things at the bear	6.0**	60.0**	2.4**	0.0	9.0**	0.2	0.9	7.0**	1.8	6.0**	30.3**	0.7	0.11
Try to hide	3.2**	113.6**	1.1	0.0	0.0	0.2	0.5	3.4*	0.4	2.2	19.8**	9.6**	0.05
Walk around the bear	2.1**	66.9**	0.7	3.7*	0.8	4.9*	0.1	1.7	3.7	1.2	0.7	1.5	0.03

Note. *$p < 0.05$, **$p < 0.01$. Appropriateness was rated on a seven-point Likert scale (1 = extremely inappropriate, 7 = extremely appropriate). For binary or continuous independent variables, color of cell reflects the direction of a significant relationship. Negative relationships are colored red and positive relationships are colored green.

Table 3.6. *Marginal mean estimate and difference-of-mean tests for appropriateness of listed actions, split by video treatment.*

	Meadow						Stream						Platform						Behavior					
Action	Boar		Sow and cubs		Subadult		Boar		Sow and cubs		Subadult		Boar		Sow and cubs		Subadult		Feeding		Curious		Aggressive	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Back away slowly	5.8	0.4	6.4	0.4	6.2	0.4	6.1	0.4	6.5A	0.4	5.8	0.4	5.6	0.4	6.0	0.4	5.3B	0.4	5.8	0.4	5.7	0.4	5.8	0.4
Kick or punch the bear	2.7	0.4	3.0	0.4	3.1	0.4	2.4	0.4	2.6	0.4	3.3	0.4	2.6	0.4	3.0	0.4	2.8	0.4	2.7	0.4	3.1	0.4	3.2	0.4
Group together	4.6	0.5	4.9	0.5	5.4	0.4	5.2	0.5	4.8	0.5	4.8	0.5	4.4	0.5	4.4	0.4	4.4	0.5	4.6	0.4	5.0	0.4	5.1	0.4
Shout or make noise	3.8	0.5	3.8	0.5	3.9	0.5	4.1	0.5	3.9	0.5	4.2	0.5	3.7	0.5	4.1	0.5	4.0	0.5	3.4B	0.5	4.0	0.5	4.5A	0.5
Shoot the bear	3.2	0.5	3.2	0.5	3.6	0.5	3.4	0.5	2.7B	0.5	3.9	0.5	3.1	0.5	3.2	0.5	3.7	0.5	3.0B	0.4	3.5	0.4	4.0A	0.4
Spray with bear spray	3.4	0.5	3.5	0.5	4.0	0.5	3.9	0.5	3.3	0.5	4.2	0.5	3.4	0.5	3.8	0.5	3.8	0.5	3.3B	0.4	3.9	0.4	4.1A	0.4
Throw things at the bear	2.7	0.4	2.7	0.4	2.5	0.4	2.2B	0.4	2.5	0.4	3.2	0.4	2.6	0.4	2.9	0.4	3.2	0.4	2.6	0.4	3.1A	0.4	3.0	0.4

Note. M represents the mean estimate with standard error, SE. Capped Roman letters in M column represent statistically significant differences among means ($p < 0.05$). Only general linear models with significant effects of "Video treatment" (Table 3.5) on appropriateness are included in this table. Appropriateness was rated on a seven-point Likert scale (1 = extremely inappropriate, 7 = extremely appropriate).

Table 3.7. *Mean estimate and difference-of-mean tests for appropriateness of listed actions, split by presence of bears in a respondent's home state.*

Action	No bears where I live		Black bears only		Both black and brown bears	
	M	SE	M	SE	M	SE
Back away slowly	5.6	0.3	5.3	0.2	6.8	0.7
Shout or make noise	3.4	0.3	3.7	0.3	4.7	0.9
Shoot the bear	2.9	0.3	2.8	0.3	4.5	0.9
Stand still and wait	5.3B	0.3	4.8A	0.3	7.2B	0.8

Note. M represents the mean estimate with standard error, SE. Capped Roman letters in M column represent statistically significant differences among means ($p < 0.05$). Only general linear models with significant effects of "Bears where you live" (Table 3.5) on appropriateness are included in this table. Appropriateness was rated on a seven-point Likert scale (1 = extremely inappropriate, 7 = extremely appropriate). Presence of bears was determined based on respondent-reported zip code of primary residence.

Table 3.8. *Mean estimate and difference-of-mean tests for appropriateness of listed actions, split by source of bear safety information.*

Action	Commercial guide		Friend or family member		I taught myself		Park or destination staff		I have not been taught	
	M	SE	M	SE	M	SE	M	SE	M	SE
Approach the bear	2.9B	0.3	2.4B	0.3	2.5B	0.3	1.9A	0.3	2.2A	0.3
Climb a tree	3.8B	0.4	3.3	0.4	3.6	0.4	2.9A	0.4	3.3	0.4
Kick or punch the bear	3.1B	0.4	2.8	0.4	3.3B	0.4	2.3A	0.4	2.7	0.4
Group together	4.8	0.4	4.6	0.4	5.3B	0.4	4.6A	0.4	4.7	0.4
Run away	3.5B	0.5	3.1	0.4	2.7	0.5	2.8A	0.4	3.0	0.4
Shout or make noise	4.2	0.5	3.6A	0.5	4.7B	0.5	3.7A	0.5	3.6A	0.4
Shoot the bear	3.7B	0.4	3.5B	0.4	3.6	0.4	2.9A	0.4	3.3	0.4
Spray with bear spray	3.8	0.5	3.7	0.4	4.3B	0.5	3.3A	0.4	3.5A	0.4
Throw food into the woods	3.5B	0.5	3.1	0.4	3.1	0.5	2.8A	0.4	2.8	0.4
Throw things at the bear	3.1BC	0.4	2.7	0.4	3.2C	0.4	2.2A	0.4	2.6AB	0.4
Try to hide	4.6B	0.4	3.9A	0.4	4.1	0.4	3.9A	0.4	4.1	0.4

Note. M represents the mean estimate with standard error, SE. Capped Roman letters in M column represent statistically significant differences among means ($p < 0.05$). Only general linear models with significant effects of "Who taught bear safety" (Table 3.5) on appropriateness are included in this table. Appropriateness was rated on a seven-point Likert scale (1 = extremely inappropriate, 7 = extremely appropriate).

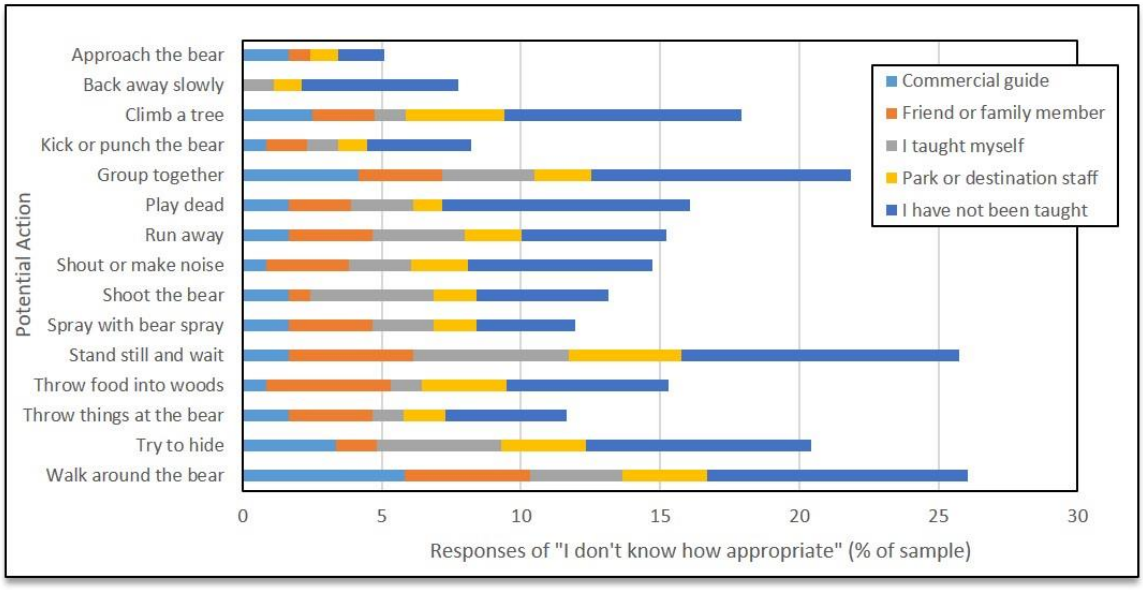


Figure 3.5. Percent of sample unsure of the appropriateness regarding fifteen potential behaviors when encountering a bear.

Management implications

As the popularity of outdoor recreation and the populations of humans and bears all continue to expand, so does the likelihood of a brown bear encounter. Not only are local residents responsible for behaving appropriately around brown bears, but park and area visitors are as well, many of whom never receive any formal safety education. To determine areas of success or potential improvement, I conducted a national online self-assessment survey of bear safety knowledge.

In preparing for increased interactions between brown bears and people, managers must continue to develop skills to best encourage safe practices among residents and park visitors alike. My results demonstrate the high potential for danger among younger and more experienced or confident individuals, who may be more likely to respond aggressively to an encounter. Respondents who had seen a bear or felt confident in their

level of safety knowledge reported higher levels of appropriateness for potentially dangerous actions, such as running away, throwing things at the bear, or kicking or punching the bear, but higher levels of appropriateness for typically correct behaviors, including backing away or grouping together to appear larger. This might have been a result of increased confidence around bears, or feelings that such behavior is unnecessary when one's past experiences have been positive. While positive encounters may help to improve feelings towards bears (Skibins and Sharp 2017, 2018), they may override previous safety instruction (Coleman 2014). To avoid this, the importance of behaving appropriately must be reinforced for all individuals, regardless of past experiences.

Among sources of bear safety information, I found park and destination staff to be the most successful in warning visitors against inappropriate behaviors such as approaching the bear, kicking the bear, running away, and throwing things at the bear, while those who were taught by themselves or a commercial guide generally viewed these actions as more appropriate. However, those taught by park or destination staff reported significantly lower levels of appropriateness for generally appropriate behaviors, such as grouping together, making noise, and spraying the bear with bear spray, than those who taught themselves. These results suggest park bear safety education efforts currently focus more on inappropriate behaviors than appropriate behaviors, leaving visitors unsure of the correct way to respond to encounters with brown bears.

Further, current bear safety instructional efforts could benefit from addressing areas of uncertainty, including climbing a tree, grouping together to appear larger, standing still and waiting for the bear to leave, trying to hide, and walking around the

bear. Regardless of experience, respondents were generally unaware of the appropriateness of these actions. Informing area residents and park visitors on these items could further improve bear safety efforts.

Near the end of the survey, I asked respondents to rank three strategies, as described by Wilson (2008), in their ability to encourage correct behavior. Of 508 complete responses, 66.3% selected being told the logic and reasoning behind instructions or policies as the most effective strategy, followed by relating with the goals of park managers, then using your own personal values to justify safe behavior. These results stress the importance of explaining to visitors and residents not only safe behavior, but the reasoning behind these suggestions as well.

The last survey question asked respondents to write in any suggestions to improve current bear safety education efforts. From these suggestions, three main ideas emerged. In order of frequency, these were 1) broaden the audience by producing public service announcements for television or online, 2) provide scenario-specific information and training, and 3) initiate a mandatory bear safety course or training prior to admission in all relevant parks. Additional suggestions included more extensive signage, classes, and educational materials, teaching bear safety in local schools and communities, providing information on bear behavior, and including the reasoning behind suggested behaviors.

From these results, I developed twelve recommendations to improve the overall effectiveness of bear safety training and education efforts.

1. All bear safety education should warn of potential emotional responses such as fear, hostility, and attentiveness that may occur during an encounter and remind users to remain calm.
2. Education efforts should continue to address the appropriateness of uncertain or popular behaviors, including climbing a tree, running away, trying to hide, grouping together, and walking around the bear.
3. Regions with established brown bear populations, as well as those on the edge of dispersing populations, should release bear safety public service announcements across several forms of media to reach the widest audience possible.
4. Place educational materials (e.g., signs, pamphlets, interactive displays, etc.) at various locations outside of park visitor's centers.
5. Provide residents and area visitors with broad information regarding bear biology, behavior, and management to encourage respect for bears and discourage behaviors that could lead to bear removal.
6. Provide logic and reasoning behind all policies, regulations, and behavioral instructions, including potential negative results.
7. Use photographs, videos, and virtual reality experiences to incorporate various scenarios and bear behaviors in preparing users for potential bear encounters.
8. Develop quizzes or other assessments of proper behavior for residents and park visitors to test their knowledge.

9. If necessary and feasible, mandatory bear safety training prior to park admission may be an effective solution. If not, consider implementing a mandatory bear safety lesson or video prior to purchasing park passes online.
10. Pay special attention to overly confident individuals, those with more experience, and those more likely to respond aggressively, particularly younger males.
11. Emphasize the importance of safe behavior around bears, regardless of an individual's past experience with bears.
12. Continue to develop curriculum and workshops for communities, private organizations, and schools in order to further inspire coexistence among the next generation.

Limitations

Threats to internal validity

A representative sample was collected with adequate sample size, but Qualtrics users and those willing to take the survey may not be entirely representative of the general American public, or those visiting national parks or other protected areas where bear viewing may occur. Although statistically accounted for by appropriate analysis, the repeated use of scales within the survey may have resulted in a testing effect, or dependency between measures.

Threats to external validity

For feasibility, survey respondents were provided with videos representing each scenario as opposed to firsthand experience. The online survey format allowed

respondents to pause and reflect prior to answering and potentially select answers believed to be correct rather than true. Further, despite significant effort to minimize nuisance variables among videos, some were unavoidable and may have unintentionally altered affective responses. Lastly, while used extensively within survey research, due to the nature of Likert-style scales, variation in responses was limited and true variation within the population may have been dampened.

Future research

Research on emotional reactions to viewing wildlife, especially carnivores, has been limited in scope. Many previous studies have addressed feelings towards carnivores (e.g., Farber an Hall 2007, Jacobs, Fehres, and Campbell 2012, Jacobs, Vaske, and Roemer 2012, Raadik and Cottrell 2007) or opinions regarding potential management action (e.g., Gilkman, Vaske, Bath, Ciucci, and Boitani 2012, Hayman, Harvey, Mazzotti, Israel, and Woodward 2014; Johansson, Sjostrom, Karlsson, and Brannlund 2012; McFarlane, Stumpf-Allen, and Watson 2007), but the focus on how these reactions impact behavior is currently understudied. This study begins to address the current knowledge gap, but more importantly, provides a foundation for continued exploration. Future research could use participant observations and onsite qualitative interviews to further understand complex emotional responses beyond what quantitative questionnaires allow. It is also important to test the applicability of virtual reality technology in representing onsite encounters. While still more contrived than firsthand experience, this developing technology could allow park managers and bear safety administrators to accurately represent different scenarios and encourage appropriate behavior despite

affective responses. Further research in virtual reality could also be used to advance visual methods within park and visitor management research.

An additional area of interest is the applicability of this research to other settings or wildlife species. Videos and questions included in this survey were targeted at brown bears, but behavioral similarities and misidentification suggest results may be highly transferable to black bears. Future research efforts should assess this degree of transferability to not only black bears, but entirely different contexts as well, such as African safaris, tiger viewing in India, underwater at coral reefs, or even deer hunting. Although it would need to be tested, I anticipate similar results across contexts. Potential hypotheses and predictions to test include:

H_1: Overall levels of positive and negative affect differ across contexts

P_1: More unique or rarer scenarios result in higher levels of overall positive affect

P_2: More dangerous scenarios result in higher levels of overall negative affect

H_2: Levels of positive and negative affect respond differently across scenarios

P_1: All scenarios produce a similar level of positive affect

P_2: More dangerous scenarios produce higher levels of negative affect

Conclusion

Bear management and safety efforts have kept the level of bear-inflicted injuries to a minimum (Gunther and Hoekstra 1998, Herrero 1970, 2018, Herrero and Fleck 1990). However, the same cannot be said for human-inflicted injuries to bears. Thousands of black bears and over a hundred grizzly bears are killed per year in North America due largely to inappropriate human behavior (Masterson 2016:16). As

interactions between humans and bears continue to increase in frequency, managers must act proactively, encouraging appropriate behavior both at home and during visits to parks and protected areas. I hope these results and recommendations will help to continue improving the efficacy of coexistence efforts across the country.

Acknowledgements

I would like to thank YouTube users GroundTruthTrekking and Photoguide for the videos used in the behavior treatments.

Literature Cited

Aumiller, L. D. and C.A. Matt. 1994. Management of McNeil river state game sanctuary for viewing of brown bears. Bears: Their Biology and Management 9:51-61.

Bateson, J. E. G. and M.K. Hui. 1992. The ecological validity of photographic slides and videotapes in simulating the service setting. Journal of Consumer Research 19(2):271-281.

Bjornlie, D.D., D.J. Thompson, M.A. Haroldson, C.C. Schwartz, K.A. Gunther, S.L. Cain, D.B. Tyers, K.L. Frey, and B.C. Aber. 2014. Methods to estimate distribution and range extent of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Society Bulletin 38(1):182-187.

Cohen, J. E. 2003. Human Population: The Next Half Century. Science 302(5648):1172–1175.

Coleman, T. C. 2014. Positive emotion in nature as a precursor to learning. International Journal of Education in Mathematics, Science, and Technology 2(3):175-190.

Cordell, H. K., C.J. Betz, and G.T. Green. 2008. Nature-based Outdoor Recreation Trends and Wilderness. International Journal of Wilderness 14(2):7–13.

——, and M.A. Tarrant. 2002. Changing demographics, values, and attitudes. Journal of Forestry October/November:28-33.

Costello, C. M., R. D. Mace, and L. Roberts. 2016. Grizzly bear demographics in the Northern Continental Divide Ecosystem, Montana: research results (2004–2014) and suggested techniques for management of mortality. Montana Department of Fish, Wildlife and Parks, Helena, Montana, USA.

Dillman, D. A. 2011. Mail and internet surveys: the tailored design method: 2007 update with new internet, visual, and mixed-mode guide. Second edition. John Wiley and Sons. Hoboken, New Jersey, USA.

Eberhardt, L.L. and J.M. Breiwick. 2010. Trend of the Yellowstone grizzly bear population. International Journal of Ecology. doi: 10.1155/2010/924197.

Farber, M. E., and T.E. Hall. 2007. Emotion and environment: Visitors' extraordinary experiences along the Dalton highway in Alaska. Journal of Leisure Research 39(2): 248-270.

Freimund, W. A., J. J. Vaske, M. P. Donnelly, and T. A. Miller. 2002. Using video surveys to access dispersed backcountry visitors' norms. Leisure Sciences 24(3-4):349-362.

Garber, S. D., and J. Burger. 1995. A 20-Yr Study Documenting the Relationship between Turtle Decline and Human Recreation. Ecological Applications 5(4):1151–1162.

Glikman, J. A., J. J. Vaske, A. J. Bath, P. Ciucci, and L. Boitani. 2012. Residents' support for wolf and bear conservation: The moderating influence of knowledge. European Journal of Wildlife Research 58(1):295-302.

Gunther, K.A. and H.E. Hoekstra. 1998. Bear-inflicted human injuries in Yellowstone National Park, 1970-1994. Ursus 10:377-384.

Goujon, A. 2018. Human Population Growth. Reference Module in Earth Systems and Environmental Sciences 1907-1912. doi: 10.1016/B978-0-12-409548-9.10755-9.

Haroldson, M. A., D. D. Bjornlie, and F. T. van Manen. 2016. Estimating number of females with cubs. Pages 13–23 in F. T. van Manen, M. A. Haroldson, and B. E. Karabensh, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana, USA.

——, C.C. Schwartz, K.C. Kendall, K.A. Gunther, D.S. Moody, K. Frey, and D. Paetkau. 2010. Genetic analysis of individual origins supports isolation of grizzly bears in the Greater Yellowstone Ecosystem. Ursus 21(1):1-13.

Hayman, R. B., R. G. Harvey, F. J. Mazzotti, G. D. Israel, and A. R. Woodward. 2014. Who complains about alligators? cognitive and situational factors influence behavior toward wildlife. Human Dimensions of Wildlife 19(6):481-497.

Herrero, S. 1970. Human injury inflicted by grizzly bears. Science 170:593-598.

——. 2018. Bear attacks: their causes and avoidance. Third edition. Lyons Press, Guilford, Connecticut, USA.

——, and S. Fleck. 1990. Injury to people inflicted by black, grizzly, or polar bears: recent trends and new insights. Bears: Their Biology and Management 8:25-32.

Jacobs, M. H., J. J. Vaske, and J. M. Roemer. 2012. Toward a mental systems approach to human relationships with wildlife: The role of emotional dispositions. Human Dimensions of Wildlife 17(1):4-15.

——., P. Fehres, and M. Campbell. 2012. Measuring emotions toward wildlife: A review of generic methods and instruments. Human Dimensions of Wildlife 17(4):233-247.

Johansson, M., M. Sjöström, J. Karlsson, and R. Brännlund. 2012. Is human fear affecting public willingness to pay for the management and conservation of large carnivores? Society & Natural Resources 25(6):610-620.

Keating, K.A. 1986. Historical grizzly bear trends in Glacier National Park, Montana. Wildlife Society Bulletin 14:83-87.

Kendall, K. C., J. B. Stetz, J. Boulanger, A. C. Macleod, D. Paetkau, and G. C. White. 2009. Demography and genetic structure of a recovering brown bear population. Journal of Wildlife Management 73:3–17.

Laven, D.N. and D.H. Krymkowski. 2005. The relationship between visitor-based standards of quality and existing conditions in parks and outdoor recreation. Leisure Sciences 27(2):157-173.

Mace, R.D., D.W. Carney, T. Chilton-Radandt, S.A. Courville, M.A. Haroldson, R.B. Harris, J. Jonkel, B. McLellan, M. Madel, T.L. Manley, C.C. Schwartz, C. Servheen, G. Stenhouse, J.S. Waller, and E. Wenum. 2012. Grizzly bear population vital rates and trend in the Northern Continental Divide Ecosystem, Montana. Journal of Wildlife Management 76(1):119-128.

Manning, R.E. and W.A. Freimund. 2004. Use of visual research methods to measure standards of quality for parks and outdoor recreation. Journal of Leisure Research 36(4):557-579.

——, W.A. Valliere, and B. Wang. 1999. Crowding norms: alternative measurement approaches. Leisure Sciences 21(2):97-115.

Masterson, L. 2016. Living with bears handbook. Second edition. PixyJack Press, Inc., Masonville, Colorado, USA.

McFarlane, B. L., R. Stumpf-Allen, and D. O. T. Watson. 2007. Public acceptance of access restrictions to grizzly bear (*Ursus arctos*) country. Human Dimensions of Wildlife 12(4):275-287.

Morehouse, A.T., T.A. Graves, N. Mikle, and M.S. Boyce. 2016. Nature vs. nurture: evidence for social learning of conflict behaviour in grizzly bears. PLos One 11(11):e0165425. doi: 10.1371/journal.pone.0165425.

Nevin, O. T. and B. K. Gilbert. 2005. Measuring the cost of risk avoidance in brown bears: Further evidence of positive impacts of ecotourism. Biological Conservation 121(4):611-622.

Newman, P., J.L. Marion, and K. Cahill. 2001. Integrating resource, social, and managerial indicators of quality into carrying capacity decision-making. The George Wright Forum 18(3):28-40.

Papouchis, C. M., F.J. Singer, and W.B. Sloan. 2001. Responses of Desert Bighorn Sheep to Increased Human Recreation. Journal of Wildlife Management 65(3):573–582.

Peck, C.P., F.T. van Manen, C.M. Costello, M.A. Haroldson, L.A. Landenburger, L.L. Roberts, D.D. Bjornlie, and R.D. Mace. 2017. Potential paths for male-mediated gene flow to and from an isolated grizzly bear population. Ecosphere 8(10):e01969. doi: 10.1002/ecs2.1969.

Proctor, M.F., S.E. Nielson, W.F. Kasworm, C. Servheen, T.G. Radandt, A.G. Machutchon, and M.S. Boyce. 2015. Grizzly bear connectivity mapping in the Canada-United States trans-border region. Journal of Wildlife Management 79(4):544-558.

Pyare, S., S. Cain, D. Moody, C. Schwartz, and J. Berger. 2004. Carnivore re-colonisation: reality, possibility, and a non-equilibrium century for grizzly bears in the southern Yellowstone ecosystem. Animal Conservation 7:71-77.

Raadik, J. and S. Cottrell. 2007. Wildlife value orientations: An Estonian case study. Human Dimensions of Wildlife 12(5): 347-357.

Schwartz, C.C., M.A. Haroldson, and G.C. White. 2010. Journal of Wildlife Management 74(4):654-667.

——, S. D. Miller, and M. A. Haroldson. 2003. Grizzly bear. Pages 556–586 in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. Second edition. Johns Hopkins University Press, Baltimore, Maryland, USA.

Shafer, C.L. 2015. Land use planning: a potential force for retaining habitat connectivity in the Greater Yellowstone Ecosystem and beyond. Global Ecology and Conservation 3:256-278.

Skibins, J. C., and R. L. Sharp. 2017. Evaluation of the brown bear viewing experience at Katmai National Park and Preserve: implications for management. Human Dimensions of Wildlife 22(5):476-482.

——, and ——. 2018. Binge watching bears: efficacy of real vs. virtual flagship exposure. Journal of Ecotourism 18(2):152-164.

UN Department of Economic and Social Affairs, Population Division. 2020. World Population by Year. https://www.worldometers.info/world-population/world-population-by-year/. Accessed 2 Feb 2020.

U.S. Census Bureau (USCB). 2020. ACS demographic and housing estimates. Retrieved from https://data.census.gov/cedsci/table?q=demographics&hidePreview=false&tid=ACSDP1Y2018.DP05&vintage=2018.

Vaske, J. J. 2008. *Survey research and analysis: Applications in parks, recreation, and human dimensions.* Venture Publishing Inc. State College, PA, USA.

Wilson, R. S. 2008. Balancing emotion and cognition: A case for decision aiding in conservation efforts. Conservation Biology 22(6):1452-1460.

Wilson, S.M., G.A. Neudecker, and J.J. Jonkel. 2014. Human-grizzly bear coexistence in the Blackfoot River Watershed, Montana; getting ahead of the conflict curve. Pages 177-214 in S.G. Clark and M.B. Rutherford, editors. Large carnivore conservation: integrating science and policy in the North American west. University of Chicago Press, Chicago, Illinois, USA.

Wittemyer, G., P. Elsen, W.T. Bean, A.C.O. Burton, and J.S. Brashares. 2008. Accelerated Human Population Growth at Protected Area Edges. Science 321(5885):123–126.

CHAPTER FOUR

DISCUSSION

Survey results

Methodologically, results of my online survey demonstrate the potential for videos as feasible surrogates for bear encounter scenarios and associated conditions. Especially when coupled with photographs of the area and directions for respondents, videos may be more immersive and realistic than photographs alone. I also found a relatively effective shortened form of the Positive and Negative Affect Schedule (PANAS), but analysis at the factor level (i.e., positive affect, negative affect) was limited as ‘alert’ and ‘attentive’ contributed to both factors. Future use of the PANAS, whether full or a shortened, should take this into account.

In terms of survey results, I found several successes as well as areas of improvement for bear safety education efforts. Respondents were fairly successful at identifying the species of bear in photographs where the defining characteristics were clear, but were less so when the bear was partially obscured or the black bear was slightly brown. Further, many reported seeing brown bears in areas they currently do not exist; likely recalling sightings of black bears. While feelings towards bears ranged from extremely negative to extremely positive, the majority were positive. Respondents reported a wide range of bear safety grades and past experience.

All items within positive affect were consistent across all setting videos while negative affect was the most intense when viewing a sow and cubs in a meadow. While viewing a sow and cubs is rare and exciting, individuals seemed aware of the potential for danger. However, respondents seemed unsure of how to feel when viewing any bear in a stream setting. Results of the behavior videos reaffirm the success of video methods, as most items within positive affect decreased with more aggressive behavior while all items

within negative affect increased. Differences between rankings of appropriateness and likelihood highlighted several areas of concern, including low likelihood of backing away or playing dead and high likelihood of throwing food into the woods, throwing things at the bear, kicking or punching the bear, and running away.

Respondents differed in their ratings of likelihood and appropriateness of potential actions. Past use history, feelings towards bears, and demographics such as gender or age all played a role in determining appropriateness while the level of appropriateness as well as the affective response largely determined the likelihood of performing such actions. For further details and discussion regarding these results, see Chapters 2 and 3.

Expanding the results

While only three survey respondents reside in states with populations of both black and brown bears, comparisons highlight interesting differences. Those in this category were more accurate at identifying bear species and reported much higher bear safety grades but, had less positive feelings towards bears than those who reside in states with black bears only or no bears at all. I did not ask for the reasoning behind these feelings, but it is assumed to be a result of the greater threat to the safety of humans and livestock posed by brown bears. It is important to note though, that this lower value still represents slightly positive feelings; an encouraging fact given the conflict surrounding the species.

A potentially sensitive result is the rated appropriateness when split by source of bear safety information. Visitors taught by park or destination staff were the most

cautious group, often reporting the lowest acceptability of an action. Those taught by commercial guides however, were the least cautious group, reporting significantly higher levels of acceptability for approaching the bear, climbing a tree, kicking or punching the bear, running away, shooting the bear, throwing things at the bear, and trying to hide. Results cannot determine whether commercial guides are teaching these behaviors as appropriate or visitors using commercial guides are simply more likely to behave in such a manner. Regardless of its source, it is important to convey consistent bear safety information across all user groups.

At the end of the survey, each respondent was asked to provide any suggestions for improving bear safety education. Many did not have any suggestions but among those who did, a couple popular ideas emerged. Based on these suggestions alone, conveying the logic and reasoning behind regulations, policies, and suggested actions would improve compliance and safe behavior. Respondents also were eager to learn more about bear behavior and receive training on how to behave in different bear encounter scenarios. Further, online, television, print, or radio advertisements were a popular suggestion to develop a knowledgeable visiting population.

The final idea that received several mentions was mandatory safety training prior to admission at relevant parks and protected areas. While beyond the bounds of the data, the popularity of this idea suggests relatively high acceptance of such a policy. However, the feasibility of this policy is limited due to the extensive time and staff required as well as the presence of users and bears in areas outside of regulated parks or protected areas. This technique is effective in areas with relatively low levels of visitation, such as Brooks

Camp in Katmai National Park, but could be difficult in more popular parks such as Yellowstone or Glacier National Parks.

To my knowledge, this was one of the first national surveys of bear safety knowledge and the first to assess affective responses as a mediator in behavior. The results presented demonstrate the effectiveness of videos as a proxy for environmental conditions. As technology continues to develop and become more accessible, videos could replace photographs within visitor carrying capacity and management research. Despite 'alert' and 'attentive' falling into both affective factors, the shortened PANAS used in this survey was an effective measure of individuals' responses to bear encounter scenarios. Lastly, the eagerness to learn more about bear safety and behavior suggests a highly encouraging improvement in popular opinion regarding coexistence with bears of both species.

Limitations

Threats to internal validity

While the PANAS scale has been well tested and items were chosen to best reflect the viewing experience, its use and abbreviation only approximates the range of true affective responses. The items selected may have different connotations among different individuals and may not have been able to successfully capture the full spectrum of affective responses. A representative sample was collected with adequate sample size, but Qualtrics users and those willing to take the survey may not be entirely representative of the general American public, or those visiting national parks or other protected areas where bear viewing may occur. Although statistically accounted for by appropriate

analysis, the repeated use of scales within the survey may have resulted in a testing effect, or dependency between measures.

Threats to external validity

For feasibility, survey respondents were provided with videos representing each scenario as opposed to firsthand experience. As a result, affective responses may have been limited or dulled. For affect, likelihood, and appropriateness questions, respondents were instructed to imagine themselves within the given scenario and respond based solely on immediate thoughts and feelings. However, the online survey format allowed respondents to select answers believed to be correct rather than true. Further, despite significant effort to minimize nuisance variables among videos, some were unavoidable. Even slight differences between videos in variables such as placement of the bear, microhabitat, lighting, or video quality may have unintentionally altered affective responses. Lastly, while used extensively within survey research, due to the nature of Likert-style scales, variation in responses was limited and true variation within the population may have been dampened.

Future research

Further research is needed to continue developing bear safety and education practices amidst an increasing risk of human-bear interactions. This study provides an excellent foundation to expand upon. The survey could be adapted to assess residents' knowledge of securing attractants and hazing potential problem bears. Further research is recommended to confirm the use of videos as surrogates for environmental and experiential conditions within visitor use management. As technology continues to

improve, virtual reality could provide increasingly realistic simulations to be used in future research as well as bear safety education. This study provides several insights into public perception and knowledge of safe behavior around bears and hopefully will inspire more research of its kind.

Appendix F: The Need for Habitat-specific Management of Bears and Bear Viewing

Erlenbach, J.A.[a], Griffin, K.[b], and C.T. Robbins[a]

[a] School of the Environment, Washington State University, Pullman WA

[b] Katmai National Park, National Park Service, King Salmon, AK

Abstract: Bear viewing continues to grow in popularity worldwide. In one popular bear viewing site in Katmai National Park (Katmai), it has increased from around 300 to over 3,000 visitor use days annually between 1998 and 2015. Human presence is known to affect wildlife and can adversely affect space use, timing of use, and energy budgets of bears. National Parks are mandated to maintain park resources unimpeded for future generations, but in order to do so, park managers need to be able to recognize both 'natural' and 'impeded' conditions within the park. A previous study in coastal Katmai found a bimodal time-use pattern of bears on a salmon stream, where use peaked in the morning and evening but was low midday. The drop midday was attributed to peak human use at that time. However, we questioned whether this drop midday was a natural pattern of use for bears on salmon streams. We used time-lapse photography and scan samples to quantify bear and human use of salt marsh and salmon streams across a gradient of human visitation pressures. On salt marshes, bear counts increased throughout the day from around 06:00 to 22:00, with the highest numbers of bears present in the late afternoon and evening. On intertidal salmon streams, bear counts were highest in the morning and evening, and lowest midday. The patterns held within habitat types, regardless of the level of human visitation. Our data suggest the need for habitat-specific management of bears and bear viewers due to natural differences in how bears use the two habitats. We also caution against a default interpretation that low bear use at the same time as high human use is caused by human use.

Introduction

The effect of human visitation on bears at bear viewing sites in Katmai National Park (Katmai) is a primary concern as bear viewing continues to grow in popularity. Bear viewing at Hallo Bay, one of Katmai's most popular coastal bear viewing locations, has increased over 1,000% between 1998 and 2015, from approximately 300 visitor use days (VUDs) to 3,392 (French 2007; NPS, personal communication). Brown bears are among the top sought-after experiences by visitors at national parks (Skibins et al. 2012), so the

need for managers to understand the consequences of bear viewers is likely to remain well into the future.

Bears often respond adversely to human presence, so understanding the role human visitors are playing in National Parks is imperative to proper management. Typical responses of bears to humans include spatial avoidance, temporal avoidance, changes in the amount of time spent in a habitat, changes in the number of bears present, changes in sex/age class of bears in a habitat, or changes in activity budgets including increased vigilance or energy spent on fleeing (Fortin et al. 2016). These behaviors can have reproductive consequences that extend beyond the localized human use area and manifest in population-level effects (Frid and Dill 2002, Shively et al. 2005).

National Parks are mandated to maintain park resources unimpeded for future generations, but in order to do so, park managers need to be able to recognize both ‘natural’ and ‘impeded’ conditions for bears within the park (NPS 1916). Previous research (Turner 2012) conducted at one backcountry coastal bear viewing location (Geographic Harbor salmon stream) showed that counts of bears from time-lapse photography were highest in the morning and evening and lowest midday when human visitation was highest. Analyses of these data showed that the pattern was related to human presence. Other research within the park has also shown that bears are affected by human visitation (Olson et al. 1998) and the supposition was that a drop in bear abundance midday could be a signature of a visitor effect on bears.

In coastal Katmai National Park, bears and bear viewers are ubiquitous on salt marshes and the mouths of salmon streams which are easily accessed from beach runways or float-plane landings near beaches. Salmon are not available year-round, but become seasonally available beginning in July. Before salmon are available, bears consume primarily vegetation and will use salt marshes from den emergence and vegetation green-up until salmon are available. Besides using the two resources during different times of year, salt marshes and salmon streams also differ in their availability to bears. The areas of coastal streams that bear viewers frequent are at the mouth of the stream—where it enters the ocean—and therefore are tidally influenced. Salmon within this portion of the stream are available only ephemerally—during the two lower tides of the day. When available, though, the salmon found there are rich in protein and calories. In contrast, salt marsh vegetation is available throughout the day, but is low in digestibility and calories. The differences in availability and quality between the two habitats could affect how bears use these resources and interact with humans there.

We questioned whether the time-use pattern found in earlier research at Geographic Creek—peak morning and evening use with low midday use by bears—might be a function of the resource itself, rather than primarily a function of human-visitation. We sought to determine whether additional data from other salmon streams with lower levels of human visitation showed the same trend and supported previous claims that midday

declines in bear use are indicative of disturbance. We compared bear and human count data from three salt marsh and three salmon stream sites across a gradient of human visitation levels to determine if daily patterns in bear use differed between the two habitat types and under different visitation regimes. Data from this study will provide baseline information on seasonal and daily use patterns for salt marsh and salmon stream sites receiving no human visitation, therefore representing an "unimpeded" signature to compare future use patterns to, as well as providing park managers with a measure of present use and disturbance at salt marsh and salmon stream bear viewing sites.

Methods

We used counts of bears and people from time-lapse photography (e.g., Huffeldt and Merkel 2013) and scan samples (Altman 1974) to examine trends in annual and daily bear and human use patterns in coastal Katmai National Park. In addition to previously collected data from Geographic Harbor (Turner 2012; 2007-2009) we collected photographs from 2010-2018 at three salt marshes and two additional salmon streams and analyzed data for all six sites. Of the three sites monitored on each habitat type, we used natural variation in human visitation to include one site with no human visitation, one with moderate human visitation, and one with high human visitation for each habitat type (appendix a). Scan samples were collected from 2015-2018 in the same salt marshes and salmon streams, and were used to validate time-lapse results.

Camera locations (figure 1) were chosen by determining the vantage-point at each site that gave the best view of the salt marsh or salmon stream being sampled, and presented substrate where cameras could be set up. In 2007-2014 cameras were contained in waterproof cases and surrounded by electric fencing. Two cameras were used at each site to provide a backup dataset if one camera failed. In 2018 cameras were mounted in metal boxes on tripods and the tripods were drilled into rock or logs (appendix b). Scan sample observations were made from the same location each day, using 8x30 handheld binoculars or a 20-60x80 spotting scope to record each animal's age class, sex, and behavior and to count people within the visible area (typically recording within <1 km; figure 2).

Cameras were placed before bears arrived to capture when bears first started using areas. Therefore, they were operational for longer than the period of primary use by bears. Photos were also collected at night and in poor weather where animals could not be quantified. Bears also moved through the habitats throughout the year, but only used salt marsh or salmon stream habitats in high numbers seasonally. For our results to be most representative of how bears use the specific resource (salt marsh or salmon streams), we restricted our analyses to the 'prime-use period' only. Photo data, therefore, consisted of three tiers—'available photos' (blue dots in figures 3 and 4; i.e., all photos taken; black dots figure 3), 'quantified photos' (i.e., photos that were of sufficient quality that we attempted to count animals in them; grey dots figure 3), and 'analyzed photos' (i.e., of the

quantified photos, ones that were within the prime-use period of that habitat by bears [prime-use was determined by looking at counts by date for each site and year and only using data around the peak frequency of use]). We also excluded observations from 00:00-02:59 from analyzed photos because there were few samples during that time. Occasionally, camera malfunctions or bear disturbance of cameras lead to gaps in photo availability for analysis. Photo gaps are represented by white space in figures 3 and 4. We used all collected scan sample observations in our analyses.

In 2007-2014 bears and humans were counted in photos manually in Arcmap (10.3.1, Environmental Systems Research Institute, Redlands, CA) and Excel (Microsoft Corporation, Redmond, WA). In 2018, animals and humans were counted automatically using ViQi (https://www.viqi.org), a cloud-based system for photo management, annotation, visualization, analysis, and data mining. ViQi employs deep learning and Convolutional Neural Network algorithms (CaffeNet [Jia et al. 2014] based on AlexNet [Krizhevsky et al. 2017]) to automate image annotations. Poor image quality of dusk and nighttime photos made quantification of bears difficult, so staff at ViQi trained the bear count model to parse images into daytime, dusk and nighttime datasets based on lighting conditions, and we quantified animals in daytime photos only. Staff at ViQi trained the model to identify bears first using transfer learning and images from the open access ImageNet dataset (http://image-net.org/index) then with 810 project images that had been manually annotated with 851 positive reference annotations of bears and thousands of negative reference counter annotations (112 boats, 2K grass, 1K trees, 1K water, 270 bear tracks, 366 snow, etc.). To minimize the occurrence of false positives (bears detected by the model when no bears were present), we also calculated an average “background” image for each day at each camera. The background reference image was used to detect changes between images and focus model detection efforts on areas where change was observed. We evaluated model performance by partitioning the annotated dataset into a training subset (60% of samples), testing subset (20% of samples), and a validation subset (20% of samples) and found that the model performed with 80% accuracy and 6% error on the validation dataset (while discarding detections with low certainty—i.e., keeping those likely to be >70% accurate).

Because of the limited coverage possible from cameras, counts of bears and people using time-lapse methods represent an index of bear and human presence at each site, not an accurate total count of individuals using the entire salt marsh or salmon stream area. Scan counts are more representative of total counts but are also limited in coverage to the area visible with a spotting scope and binoculars. The areas where bears were counted between time-lapse and scan counts differs slightly (figures 1 & 2). Ages and sexes of individuals were not determined from time-lapse data because individuals were often barely distinguishable in images. Thus, counts of bears from photos include all visible individuals (adults, cubs, etc.) rather than independent bears (adults and subadults, but

not cubs) as we typically report. Bears were aged/sexed in scan samples and are presented as independent bears only.

Salt marsh sites

Salt marsh sites were located in Katmai Bay, Swikshak Bay, and Hallo Bay (figures 1 & 2).

Katmai Bay ('Katmai_M'; estimated location: 58.002265°, -155.037538°) was a no human visitation salt marsh site (VUDs < Aug. 1 each year: 7 ± 14 SD, 2007-2018; although visitors could not access the area where time-lapse images were taken). Time-lapse photos were taken from 6/4/10-9/12/10 (85 days; 2,060 photos), 6/5/11-9/26/11 (103 days; 2,308 photos), 5/29/13-8/5/13 (51 days; 1,479 photos), 5/23/14-9/2/14 (68 days; 1,259 photos). We analyzed photos from 6/1 through 7/31 for the Katmai M salt marsh site, resulting in 189 days (48 days 2011, 53 days 2012, 43 days 2013, 45 days 2014) and 4,722 photos analyzed (1,172 photos 2011; 1,272 photos 2012; 1,345 photos 2013; 933 photos 2014; figure 3). There were gaps in photo days during 6/1/1-6/3/10; 6/1-6/4/11; 6/20/13-7/9/13; and various multiple-day intervals throughout 2014. We used Nikon Coolpix 4300 cameras (4.0 megapixels), wide-angle lenses, and a Digisnap 2800 time-lapse controller to collect photos. Photos were taken at a 30-minute picture interval. We collected scan samples ('Katmai_SaltMarsh'; location: 58.00245°, -153.03081° from 6/5/18-6/19/18 for 15 days and 190 samples (figure 4). Scan samples were collected half-hourly from two hours before low tide to two hours after low tide, and at two random hours.

Swikshak Bay ('Swikshak_M'; location: 58.6201°, -153.75194°) was a moderate human visitation salt marsh site (VUDs < Aug. 1: 154 ± 109 SD, 2007-2018). We collected time-lapse photos from 6/2/12-10/9/12 (84 days; 1,889 photos), 4/28/13-9/22/13 (57 days; 1,490 photos), and 4/28/14-9/23/14 (58 days; 1,221 photos). We analyzed photos from 6/2 through 7/31 for the Swikshak_M salt marsh site, resulting in 94 days (50 days 2012, 21 days 2013, 23 days 2014) and 2,327 photos analyzed (1,275 photos 2012, 576 photos 2013, 476 photos 2014; figure 3). There were gaps in photo days during 6/2-6/20/13 and 6/2-6/13/14. We used Nikon Coolpix 4300 cameras (4.0 megapixels), wide-angle lenses, and a Digisnap 2800 time-lapse controller to collect photos. Photos were taken at a 30-minute picture interval. We collected scan samples ('Swikshak_SaltMarsh'; location: 58.61684°, -153.74245°) from 6/21/18-7/3/18 for 12 days and 132 samples (figure 4). Scan samples were collected half-hourly from two hours before low tide to two hours after low tide, and at two random hours.

Hallo Bay ('Hallo_Marshes') was a high human visitation salt marsh site (VUDs < Aug. 1: 2,028 ± 426 SD, 2007-2018) with three salt marsh cameras: two in the meadow north of Serpent Creek ('Hallo_MNN' and 'Hallo_MNS'; location: 58.43937°, -154.07024°) and one in the meadow south of Serpent/Middle Creek ('Hallo_MS'; 58.42635°, -

154.06790°). We collected time-lapse photos from 5/2/18-10/23/18 at Hallo_MNN and Hallo_MNS (175 days; 8,338 photos at MNN and 8,344 photos at MNS) and from 5/2/18-12/12/18 at Hallo_MS (225 days, 10,761 photos). We analyzed photos from 6/1 through 7/31 for all Hallo salt marshes (52 days MNN, 57 days MNS, and 61 days MS; 1,781 photos MNN, 2,028 photos MNS; and 2,191 photos MS; figure 3) and summed counts from the same date-time for all cameras to yield a 'Hallo_Marshes'. There were photos for 61 days and 2,276 datetimes in the Hallo_Marshes dataset. There were no gaps in photo days. We used a Reconyx Ultrafire PC9 (8 mp) at MNS and MS and a Bushnell Trophy Cam Aggressor (model 119777; 14 mp) at MNN to collect photos. Photos were taken at a 30-minute picture interval. We collected scan samples ('Hallo_SaltMarsh'; location: 58.44142°, -154.07051°) from 6/11/15-6/25/15, 7/14/15-7/27/15, 6/21/16-6/30/16, and 7/21/16-7/31/16 for 49 days (28 in 2015, 21 in 2016) and 313 samples (190 in 2015, 123 in 2016; figure 4). Scan samples were collected hourly from two hours before low tide to two hours after low tide, and at two random hours.

Salmon Stream Sites

Salmon stream sites were located in Dakavak Bay (Dakavak Creek), Hallo Bay (Serpent/Middle Creek), and Amalik Bay/Geographic Harbor (Geographic Creek; figures 1 & 2).

Dakavak Creek was a no human visitation salmon stream site (VUDs $\geq$ Aug. 1: 4 $\pm$ 9 SD, 2007-2018) with two camera locations: the intertidal portion of Dakavak Creek ('Dakavak_CRIT'; location: 58.06572°, -154.67307°) and the inland portion of Dakavak Creek ('Dakavak_CRIN'; location: 58.06717°, -154.65656°). Time-lapse photos were collected from 5/1/18-10/8/18 (142 days CRIT, 161 days CRIN; 6,674 photos CRIT, 7,686 photos CRIN). We analyzed photos from 7/15 through 10/8 for Dakavak_CRIT (85 days; 1,527 photos) and from 8/15 through 10/8 for Dakavak_CRIN (55 days; 1,380 photos; figure 3). There were no gaps in photo days during the period we analyzed photos, but a gap in photo collection from 6/13-7/1/18 at CRIT. We used Reconyx Ultrafire PC9 (8 mp) to collect photos. Photos were taken at a 30-minute picture interval. We collected scan samples ('Dakavak_CR'; location: 58.06718°, -154.59964°) from 8/21/18-9/1/18 for 11 days and 162 samples (figure 4). Scan samples were collected half-hourly from two hours before low tide to two hours after low tide, and at two random hours.

Serpent/Middle Creek ('Hallo_CRIT'; location: 58.44058°, -154.07011°) was a moderate human visitation salmon stream site (VUDs $\geq$ Aug. 1: 676 $\pm$ 187 SD, 2007-2018) with time-lapse photos from 5/2/18-10/23/18 (175 days; 8,353 photos). We analyzed photos from 7/1 through 8/15, resulting in 46 days and 1,527 photos analyzed (figure 3). There were no gaps in photo days. We used a Bushnell Trophy Cam Aggressor (model 119777; 14 mp) to collect photos. Photos were taken at a 30-minute picture interval. We collected scan samples ('Hallo_CR'; location: 58.44142°, -154.07051° from 8/4/15-8/17/15,

9/2/15-9/11/15, 8/1/16-8/8/16, 8/25/16-9/7/16 for 46 days (24 in 2015, 22 in 2016) and 292 samples (154 in 2015, 138 in 2016; figure 4). Scan samples were collected hourly from two hours before low tide to two hours after low tide, and at two random hours.

Geographic Creek (‘Geographic_CRIT’; estimated location: 58.124734°, -154.607670°) was a high human visitation salmon stream site (VUDs > Aug. 1: 873 + 244 SD, 2007-2018). Data are those collected and analyzed by Turner 2012, with time-lapse photos from 7/13/07-9/21/07 (31 days; 2,855 photos), 7/14/08-9/20/08 (27 days; 1,642 photos), and 7/13/09-9/21/09 (65 days; 1,465 photos). We analyzed photos from 7/14 through 9/20, resulting in 116 days (28 in 2007; 25 in 2008; 63 in 2009) and 5,779 photos (2,733 in 2007; 1,640 in 2008; 1,406 in 2009; figure 3). There were unknown gaps in photo days. Turner used Nikon Coolpix 4300 cameras (4.0 megapixels), wide-angle lenses, and a Digisnap 2800 time-lapse controller to collect photos. Photos were taken at a 10-minute time-lapse interval during 2007-2008 and a 30 minute interval in 2009. Due to an overwhelming number of photos resulting from the short intra-picture interval in 2007-2008, photos used in analyses for 2007-2008 were from every other day or every fourth day. In 2009 all photos were analyzed. We collected scan samples (‘Geographic_CR’; location: 58.12131, -154.59964) from 8/6/18-8/16/18 for 10 days and 139 samples (figure 4). Scan samples were collected half-hourly from two hours before low tide to two hours after low tide, and at two random hours.

Example photos from each camera are shown in figure 5.

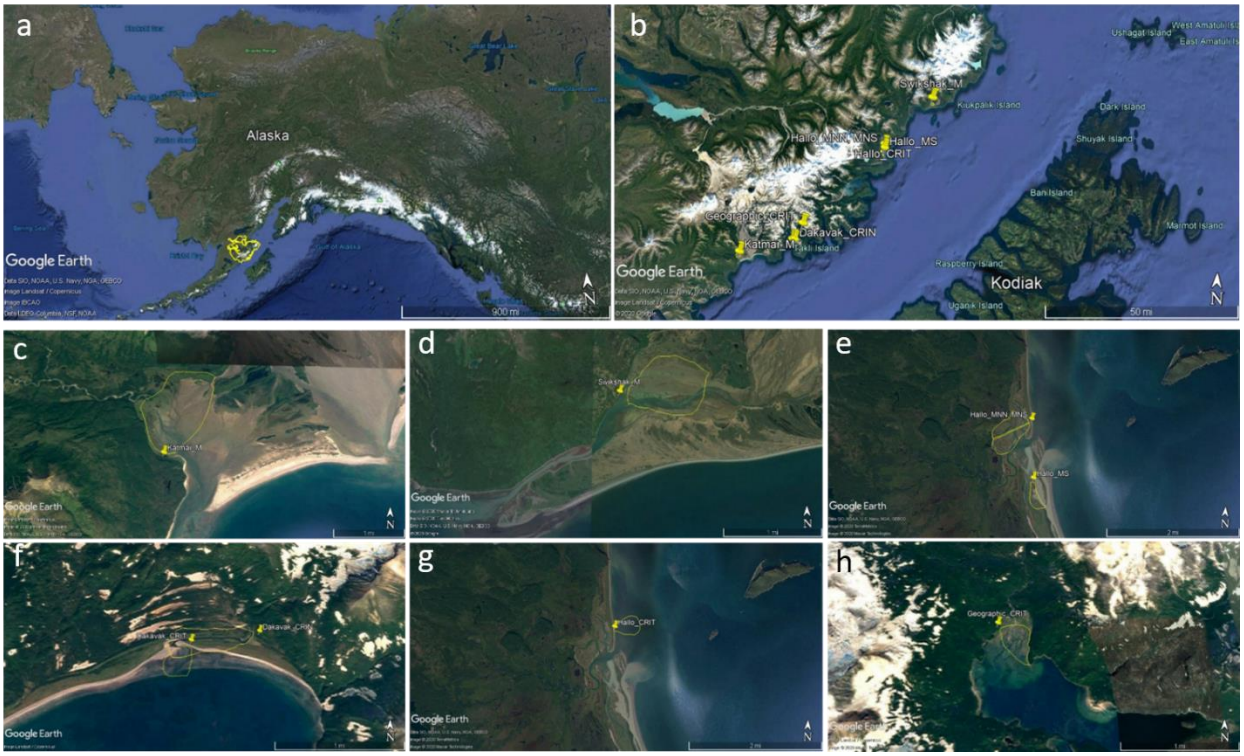


Figure 1. Time-lapse photography sites in Katmai National Park, Alaska 2007-2018. a) Katmai National Park, shown in yellow; b) overview of time-lapse camera sites in coastal Katmai National Park; c-e) salt marsh time-lapse camera sites and approximate coverage area of cameras at each site [c: Katmai Bay, d: Swikshak Bay, e: Hallo Bay]; f-h) salmon stream time-lapse camera sites and approximate coverage areas of cameras at each site [f: Dakavak Bay, g: Hallo Bay, h: Geographic Harbor].

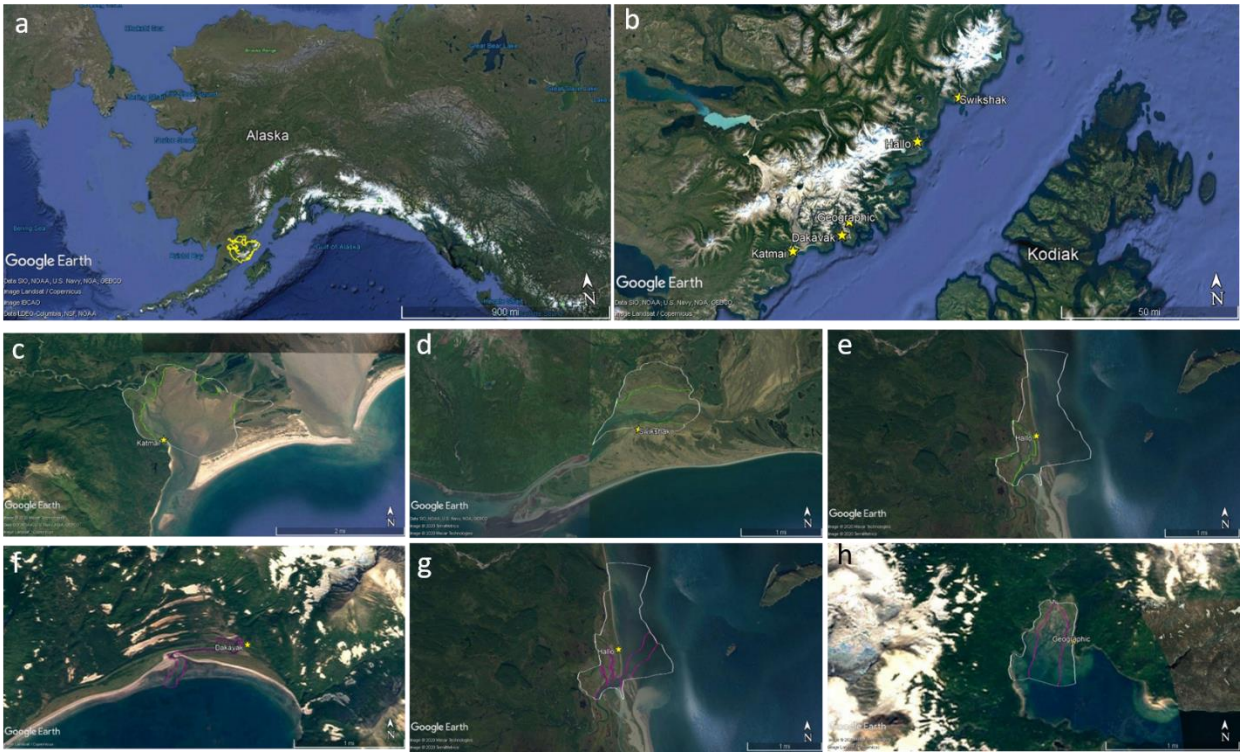


Figure 2. Scan sample sites in Katmai National Park, Alaska 2007-2018. a) Katmai National Park, shown in yellow; b) overview of scan count sites in coastal Katmai National Park (same bays as time-lapse photography study); c-e) salt marsh scan sample sites and approximate count coverage area at each site [c: Katmai Bay, d: Swikshak Bay, e: Hallo Bay]; f-h) salmon stream scan sample sites and approximate count-area coverage at each site [f: Dakavak Bay, g: Hallo Bay, h: Geographic Harbor].

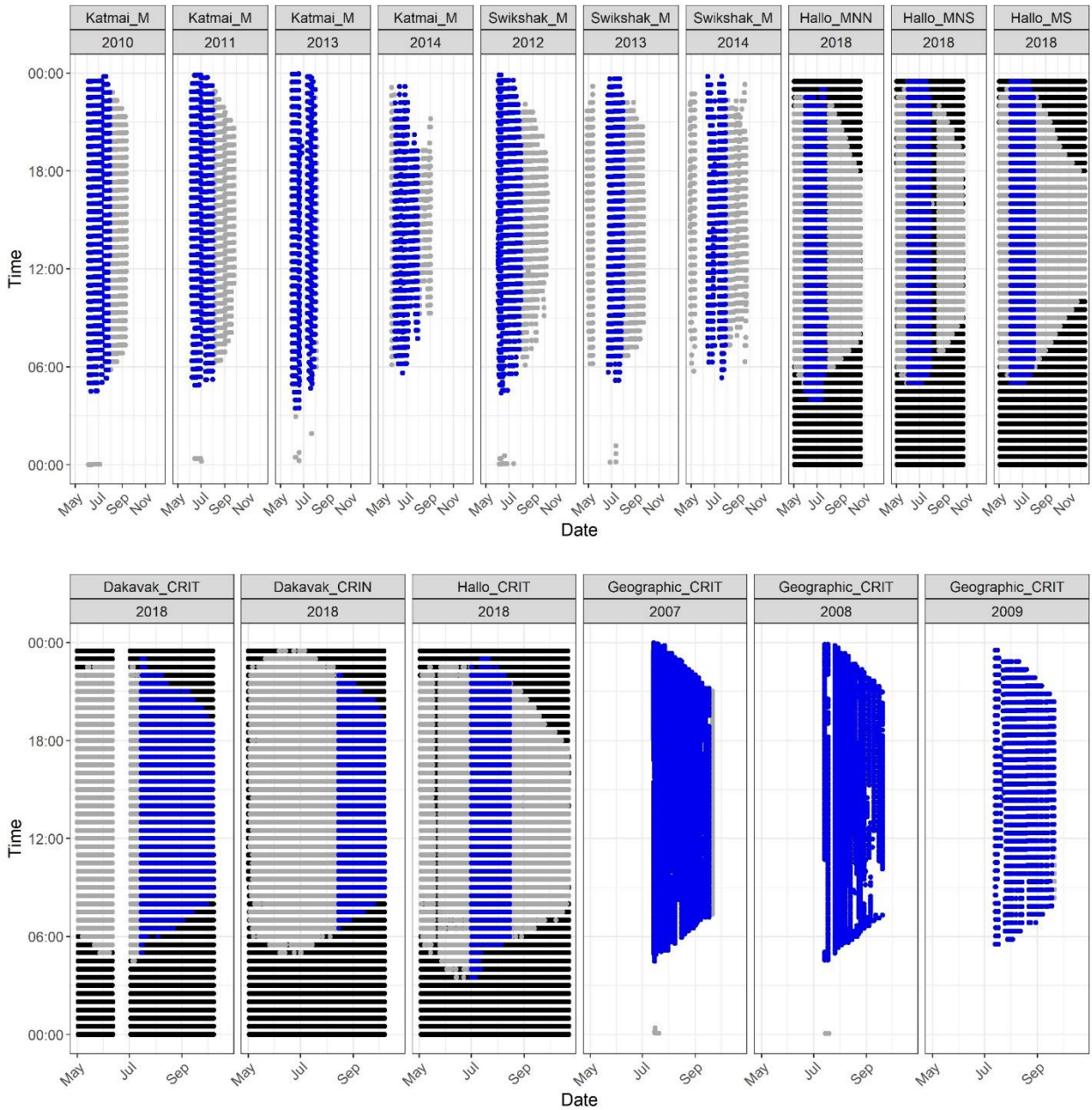


Figure 3. Dates and times of photo captures (‘available’, black), quantifiable photos based on photo quality (‘quantified’, grey), and photos used in analyses (‘analyzed’, blue) for quantification of bear and human use of salt marshes (top row) and salmon streams (bottom row) via time-lapse photography, Katmai National Park 2007-2018.

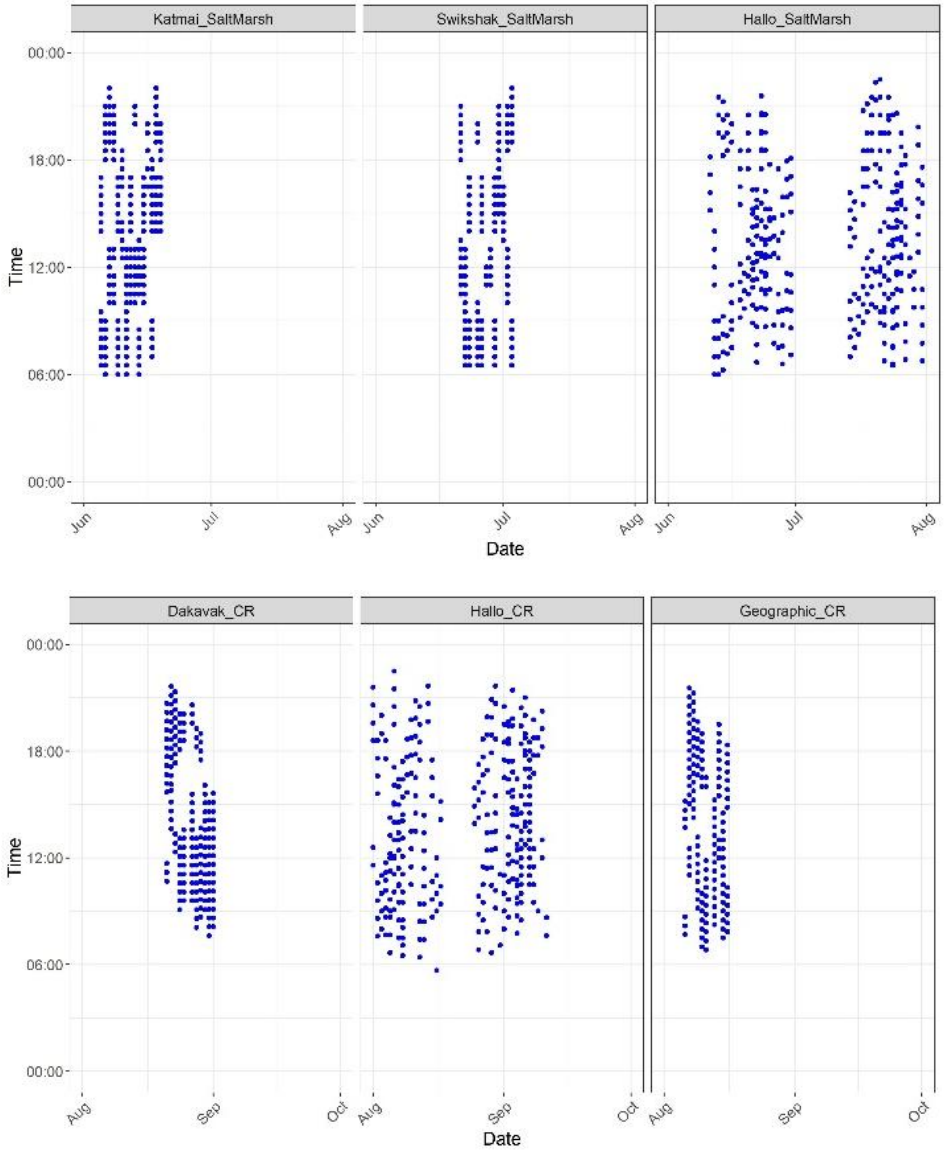


Figure 4. Dates and times of scan samples used in analyses (blue) for quantification of bear and human use of salt marshes (left) and salmon streams (right), Katmai National Park 2007-2018.

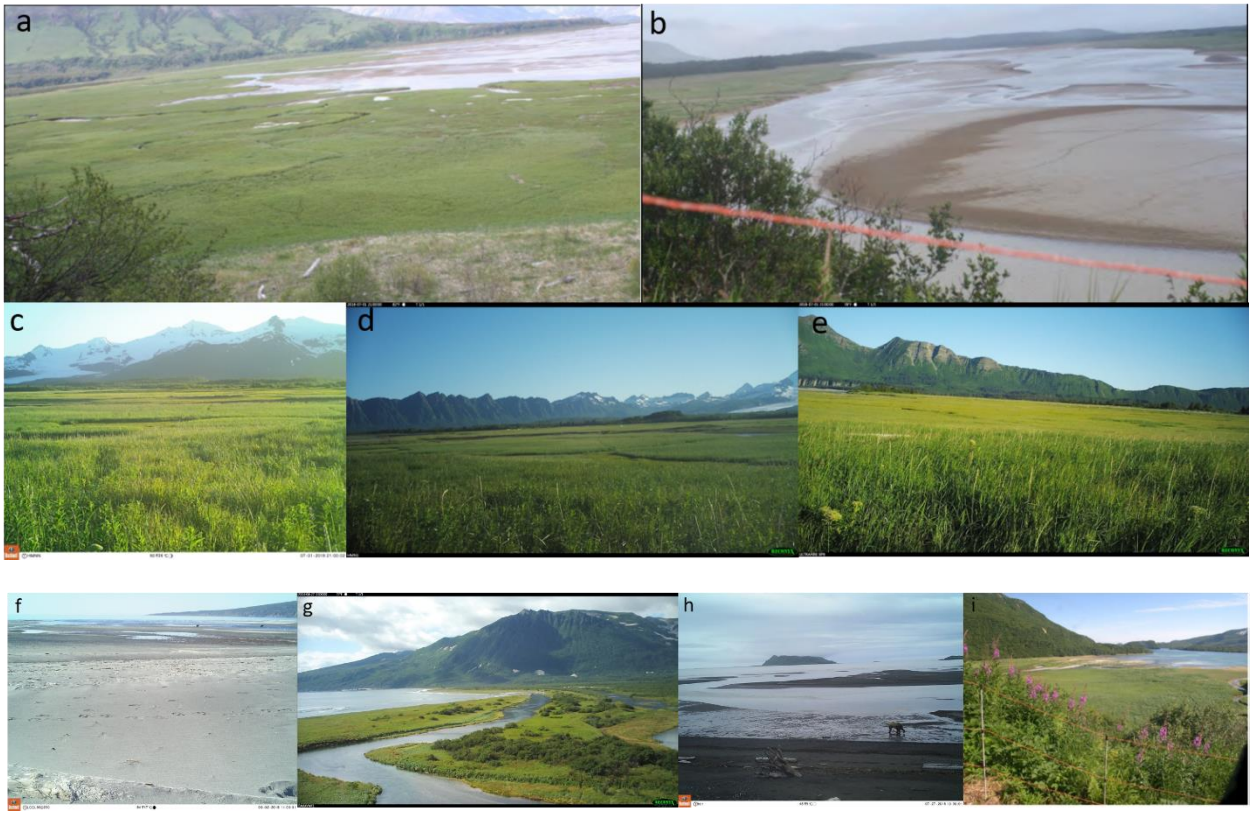


Figure 5. Time-lapse photography example photos from each camera site, Katmai National Park, 2007-2018. a-e) salt marsh sites [a: Katmai_M, b: Swikshak_M, c: Hallo_MNN, d: Hallo_MNS, e: Hallo_MS], f-i) salmon stream sites [f: Dakavak_CRIT, g: Dakavak_CRIN, h: Hallo_CRIT, i: Geographic_CRIT].

Data Analysis

All results were summarized in R 3.6.3 (R Core Team 2018). We examined trends in time-use by bears in both time-lapse and scan count data by fitting local polynomial regressions (LOESS curves) to count data. Regression and summaries of counts include data from 03:00-23:59. We performed Analysis of Variance on time-lapse data only. We compared standardized bear counts (mean number of bears per photo in each period of each day, less the daily mean number of bears per photo) which controlled for potential differences in day or week patterns and isolated within day patterns, which we were most interested in. We parsed data into three time blocks: morning-06:00-11:59, midday-12:00-17:59, and evening-18:00-23:59, excluding 0:00-5:59 because of small sample size, and examined the relationship between time and habitat type (salt marsh or salmon stream) using a time block by habitat type interaction. We then examined the effect of visitation on each habitat type by looking at the significance of the main effect of

visitation level (none, moderate, high) within each habitat type. We followed significant main effects with Tukeys HSD tests for differences within the main effects. We used an alpha level of 0.05 to assess significance.

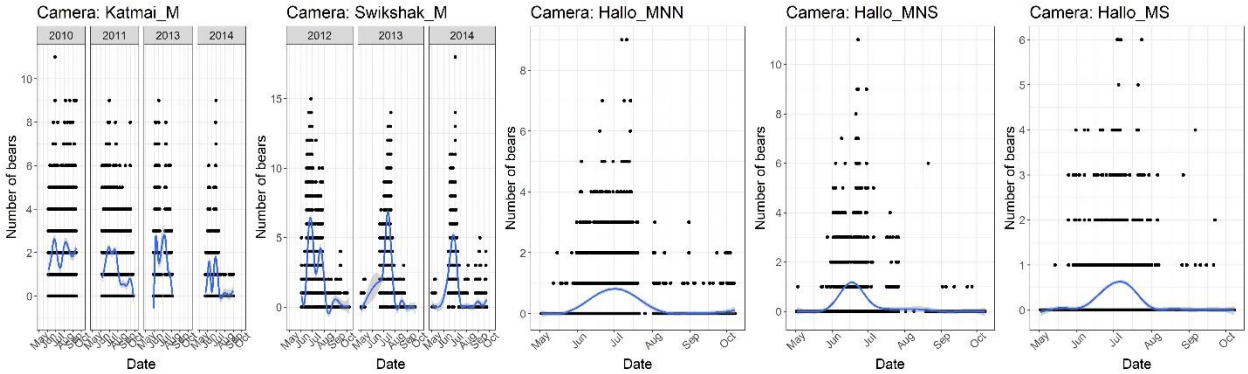
Results

Time-lapse

Bears were observed in salt marsh photos beginning as early as April 28, although cameras were not deployed before that date, and bears were present as late as Oct. 7. Bear use at monitored sites occurred more consistently beginning mid- to late May and early June, with peak use occurring in early July with diminishing use occurring around August 1 (figure 6).

Bear use of salmon streams varied by location. Bears were observed in salmon stream photos at Hallo_CRIT as early as June 3 and as late as Oct. 10, but they used salmon stream habitat most consistently for fishing in mid-July. At Dakavak bears were observed in photos as early as May 2 and as late as Oct. 8, but they were consistently seen fishing beginning in late July in the intertidal at Dakavak_CRIT but not until mid-August in the inland portion of Dakavak Creek (Dakavak_CRIN). Peak use of Dakavak Creek was in late September to early October, although cameras were only present until Oct. 8. Bear use of creek habitat in Geographic Harbor peaked in early September (figure 6).

No humans were counted in Katmai_M or Dakavak Creek photos, as expected (figure 7). Other sites with human presence showed use patterns similar to bear patterns: human use of salt marshes was high in June and July, and human use of salmon streams was high in July in Hallo and in August and September in Geographic. The concurrence of bears and people occurs because people are being brought in to view bears.



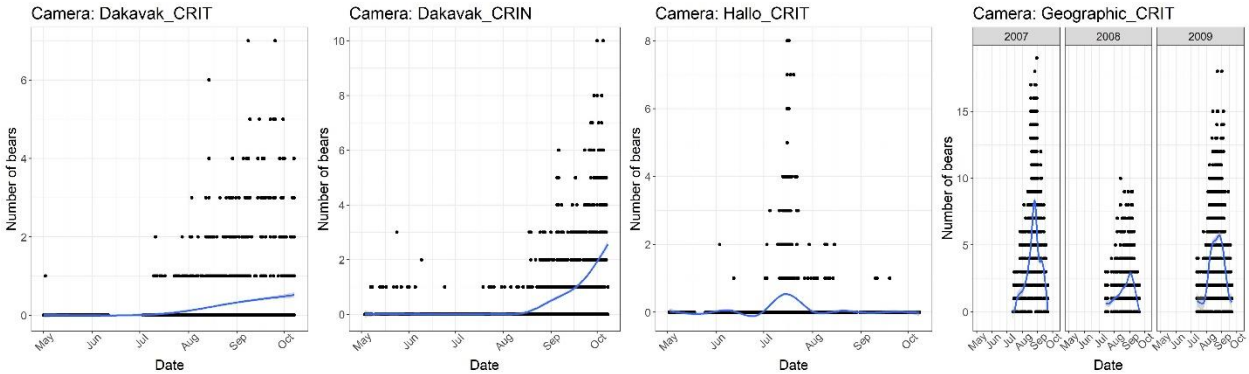


Figure 6. Raw bear count data by date (black dots) from time-lapse photography at salt marsh (top row) and salmon stream (bottom row) sites in Katmai National Park, 2007-2018. Trend shown in blue.

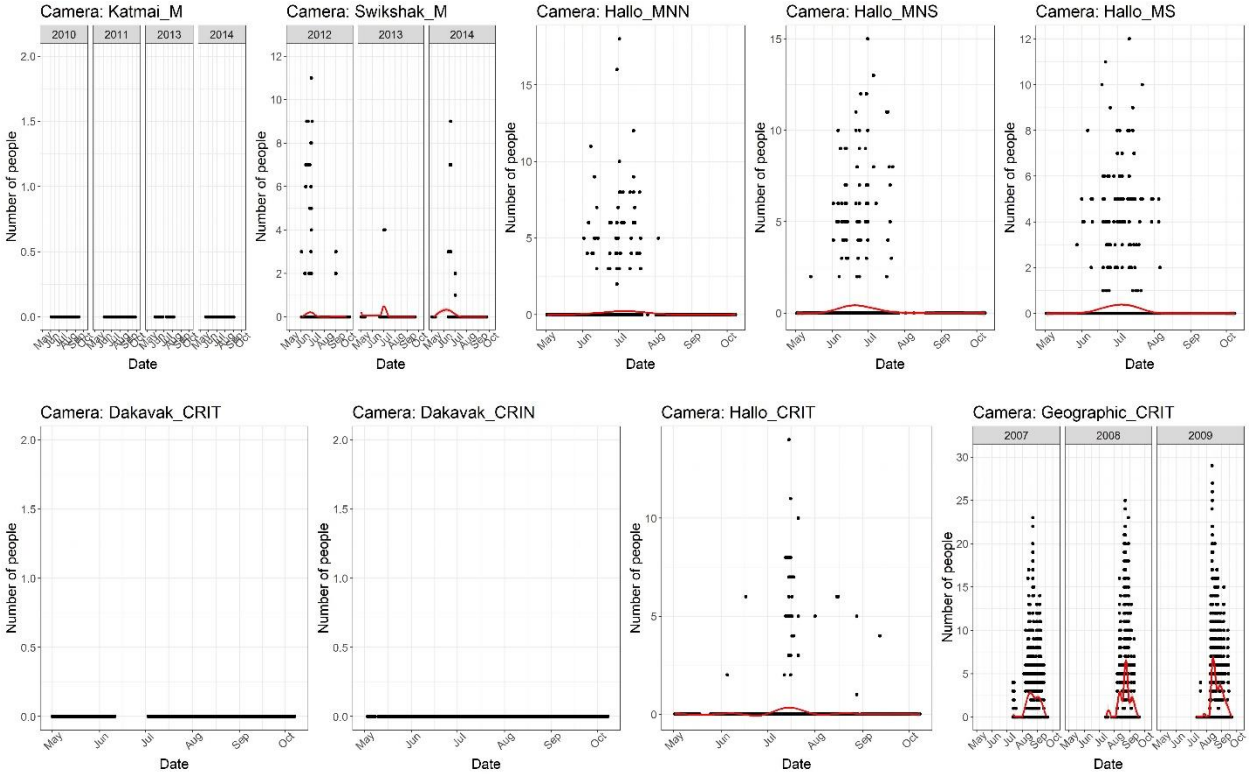


Figure 7. Raw human count data by date (black dots) from time-lapse photography at salt marsh (top row) and salmon stream (bottom row) sites in Katmai National Park, 2007-2018. Trend shown in red.

Bear counts by time from photos follow different trends between salt marsh and salmon stream habitats (figures 8, 9, 10). Bear counts are low in the morning on salt marshes and increase gradually throughout the day to a high around 21:00. The pattern was similar across all levels of human visitation (i.e. at all camera sites). Bear counts on salmon streams showed higher numbers of bears in the morning and evening, with a midday low around 15:00. Statistically, the interaction between time block (morning: 06:00-11:59, midday: 12:00-17:59, evening: 18:00-23:59) and habitat type (salt marsh vs salmon stream) was significant, also indicating differences in pattern of counts associated with time between habitats ($F_{(2, 1,111)} = 95.77$, $p < 0.001$). There was not a significant main effect of visitation on saltmarsh ($F_{(2, 528)} = 2.39$, $p = 0.092$) or salmon stream time-abundance trends ($F_{(2, 579)} = 1.7$, $p = 0.18$). The effect of time block on standardized bear counts was significant in both habitats ($F_{(2, 528 \text{ and } 579)} = 34.4$, $p < 0.001$): within salt marsh habitat morning counts are lower than midday and evening counts (p = 0) but midday and evening counts are not different ($p = 0.1$). Within salmon stream habitat all time blocks were significantly different ($p = 0$), but mean midday counts were consistently lower than the other counts.

Bear abundance in photos during the prime salt marsh use period was on average 0.41 bears per photo from 03:00-05:59, 1.34 from 06:00-11:59, 1.75 from 12:00-17:59, and 1.95 from 18:00-23:59 at Katmai_M; 0.37 bears per photo from 03:00-05:59, 1.75 from 06:00-11:59, 3.51 from 12:00-17:59, and 3.94 from 18:00-23:59 at Swikshak_M; and 0.09 bears per photo from 03:00-05:59, 0.34 from 06:00-11:59, 0.60 from 12:00-17:59, and 0.63 from 18:00-23:59 at Hallo_Marshes. Human abundance during the prime salt marsh use period was zero for all time periods at Katmai_M; was on average 0.0 people per photo from 03:00-05:59, 0.07 from 06:00-11:59, 0.18 from 12:00-17:59, and 0.07 from 18:00-23:59 at Swikshak_M; and 0.0 people per photo from 03:00-05:59, 0.25 from 06:00-11:59, 0.33 from 12:00-17:59, and 0.13 from 18:00-23:59 at Hallo_Marshes (table 1).

Bear abundance during the prime salmon stream use periods was on average 0.0 bears per photo from 03:00-05:59, 0.30 from 06:00-11:59, 0.22 from 12:00-17:59, and 0.29 from 18:00-23:59 at Dakavak_CRIT; 0.10 bears per photo from 03:00-05:59, 0.23 from 06:00-11:59, 0.18 from 12:00-17:59, and 0.24 from 18:00-23:59 at Hallo_CRIT; and 0.29 bears per photo from 03:00-05:59, 4.84 from 06:00-11:59, 2.20 from 12:00-17:59, and 3.26 from 18:00-23:59 at Geographic_CRIT. Human abundance during the prime salmon stream use periods was 0 people per photo at Dakavak_CRIT during all time-periods; 0 people per photo from 03:00-05:59, 0.24 from 06:00-11:59, 0.08 from 12:00-17:59, and 0.07 from 18:00-23:59 at Hallo_CRIT; and 0.0 people per photo from 03:00-05:59, 1.96

from 06:00-11:59, 3.48 from 12:00-17:59, and 0.6 from 18:00-23:59 at Geographic_CRIT (table 1).

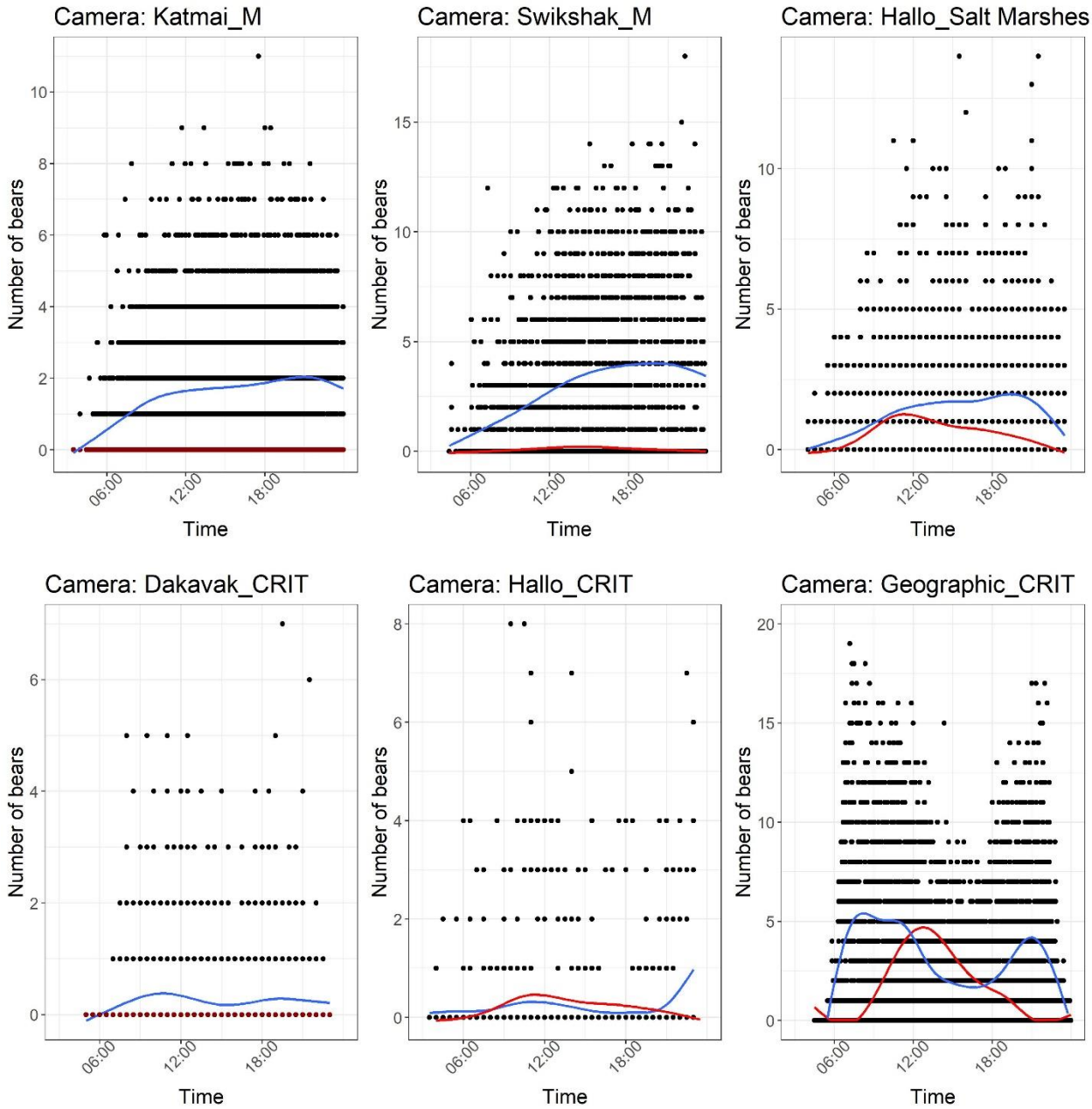
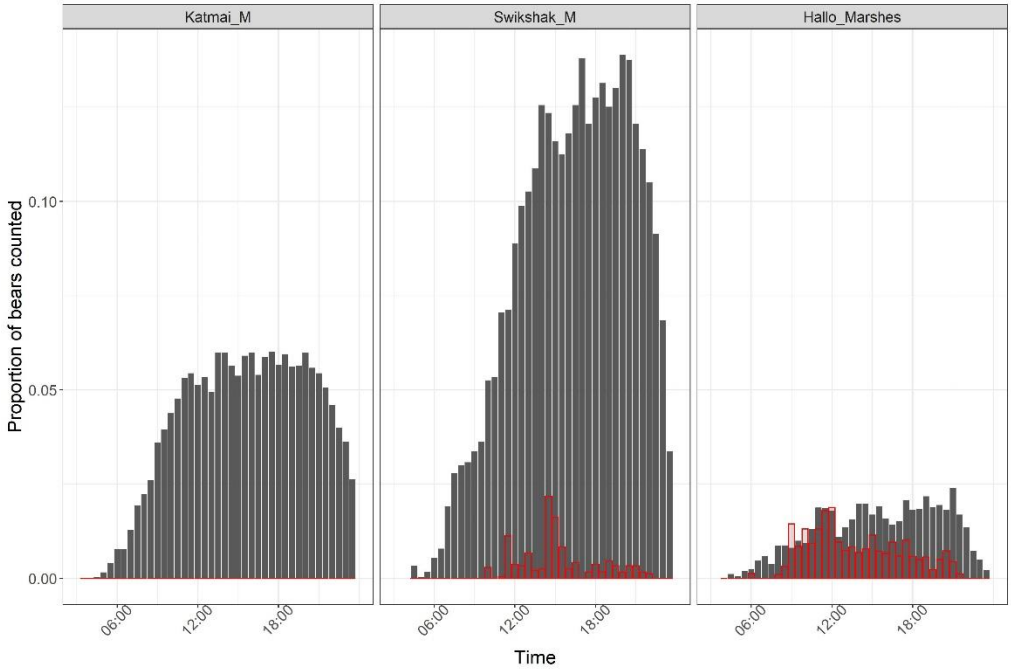


Figure 8. Raw bear count data by time from time-lapse photography (black dots) at salt marsh (top row) and salmon stream (bottom row) sites in Katmai National Park, 2007-2018. Trends in bear counts in blue, human counts in red.



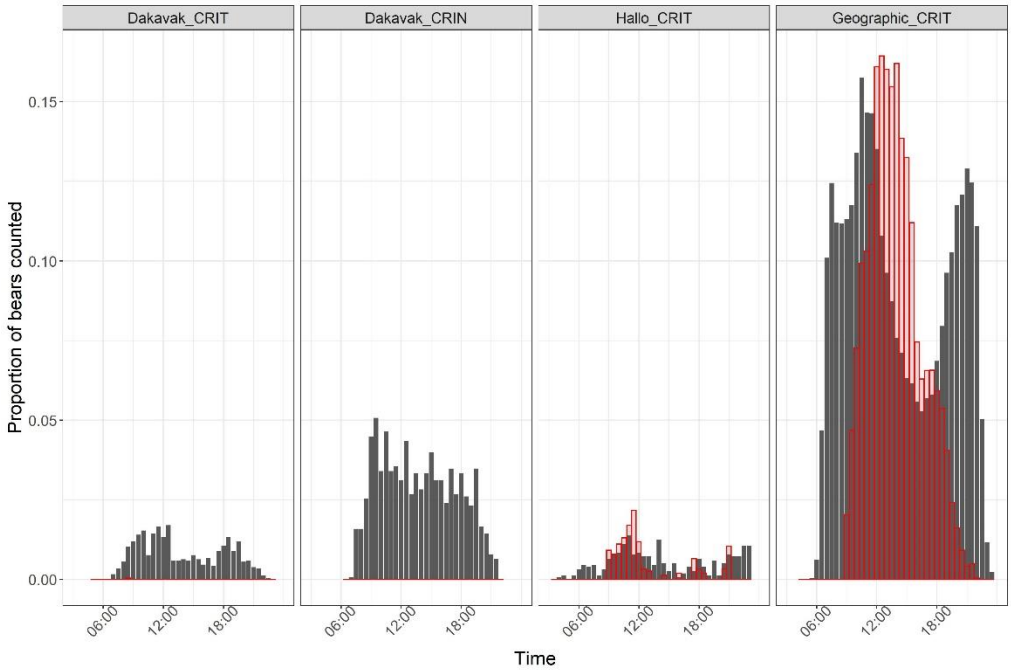


Figure 9. Proportion of bears counted at each time period during the prime use season (i.e., total animals counted at time/total observations during prime use season at that

camera) from time-lapse photography at salt marsh (top row) and salmon stream (bottom row) sites in Katmai National Park, 2007-2018. Bear proportions in black, human proportions in red.

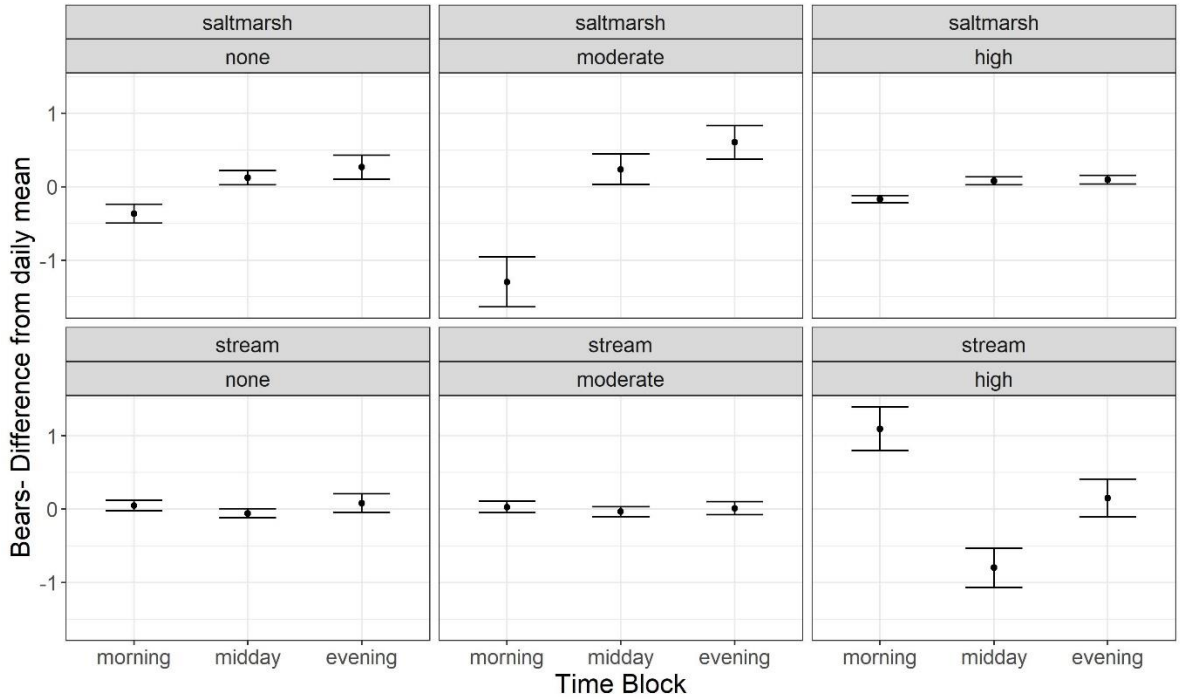


Figure 10. Standardized bear counts (mean + 95% confidence interval) from time-lapse photos at each salt marsh and salmon stream site in Katmai National Park, 2007-2018 (top row: Katmai_M, Swikshak_M, Hallo_M; bottom row: Dakavak_CRIT, Hallo_CRIT, Geographic_CRIT). Bear counts are standardized by day—dividing the average number of bears counted in each time block per day (morning: 06:00-11:59, midday: 12:00-17:59, evening: 18:00-23:59) by the daily mean number of bears counted during all timeblocks.

Table 1. Average number of bears per photo in salt marshes (top) and salmon streams (bottom), Katmai National Park time-lapse photography study, 2007-2018. Night: 0:00-05:59; morning: 06:00-11:59, midday: 12:00-17:59, evening: 18:00-23:59.

			Bears					People					
camera.combo	**vis.**	**time.block**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**n**
Dakavak_CRIT	none	night	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
Dakavak_CRIT	none	morning	0.30	0.76	0.03	0.25	0.35	0.00	0.04	0.00	0.00	0.00	794
Dakavak_CRIT	none	midday	0.22	0.64	0.02	0.18	0.25	0.00	0.00	0.00	0.00	0.00	1016
Dakavak_CRIT	none	evening	0.29	0.84	0.04	0.22	0.36	0.00	0.00	0.00	0.00	0.00	534
Hallo_CRIT	mod.	night	0.10	0.41	0.06	-0.02	0.21	0.00	0.00	0.00	0.00	0.00	51
Hallo_CRIT	mod.	morning	0.23	0.93	0.04	0.15	0.31	0.24	1.32	0.06	0.12	0.35	510
Hallo_CRIT	mod.	midday	0.18	0.73	0.03	0.11	0.24	0.08	0.66	0.03	0.02	0.13	542
Hallo_CRIT	mod.	evening	0.24	0.84	0.04	0.16	0.32	0.07	0.66	0.03	0.01	0.13	424
Geographic_CRIT	high	night	0.29	0.72	0.07	0.16	0.42	0.00	0.00	0.00	0.00	0.00	119
Geographic_CRIT	high	morning	4.84	4.13	0.08	4.68	5.00	1.96	3.90	0.08	1.81	2.11	2639
Geographic_CRIT	high	midday	2.20	2.36	0.04	2.12	2.28	3.48	5.07	0.08	3.31	3.64	3656
Geographic_CRIT	high	evening	3.26	3.31	0.06	3.14	3.39	0.60	1.83	0.04	0.53	0.67	2734
Dakavak_CRIN	none	morning	0.92	1.50	0.07	0.78	1.06	0.00	0.00	0.00	0.00	0.00	455
Dakavak_CRIN	none	midday	0.85	1.33	0.05	0.74	0.95	0.00	0.00	0.00	0.00	0.00	626
Dakavak_CRIN	none	evening	0.75	1.30	0.08	0.60	0.90	0.00	0.00	0.00	0.00	0.00	299

			Bears					People					
camera.combo	**vis.**	**time.block**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**n**
Katmai_M	none	night	0.41	0.93	0.08	0.26	0.57	0.00	0.00	0.00	0.00	0.00	135
Katmai_M	none	morning	1.34	1.49	0.04	1.26	1.42	0.00	0.00	0.00	0.00	0.00	1427
Katmai_M	none	midday	1.75	1.69	0.04	1.67	1.82	0.00	0.00	0.00	0.00	0.00	1914
Katmai_M	none	evening	1.95	1.71	0.05	1.86	2.04	0.00	0.00	0.00	0.00	0.00	1431
Swikshak_M	mod	night	0.37	0.81	0.14	0.09	0.65	0.00	0.00	0.00	0.00	0.00	35
Swikshak_M	mod.	morning	1.75	2.26	0.09	1.57	1.92	0.07	0.71	0.03	0.01	0.12	623
Swikshak_M	mod.	midday	3.51	3.17	0.10	3.31	3.71	0.18	1.06	0.03	0.11	0.25	952
Swikshak_M	mod.	evening	3.94	3.65	0.13	3.69	4.20	0.07	0.51	0.02	0.03	0.10	788
Hallo_Marshes	high	night	0.09	0.33	0.02	0.05	0.13	0.00	0.00	0.00	0.00	0.00	261
Hallo_Marshes	high	morning	0.34	0.86	0.02	0.30	0.38	0.25	1.32	0.03	0.19	0.30	1996
Hallo_Marshes	high	midday	0.60	1.18	0.03	0.55	0.65	0.33	1.42	0.03	0.27	0.39	1995
Hallo_Marshes	high	evening	0.63	1.26	0.03	0.57	0.69	0.13	0.90	0.02	0.08	0.17	1757

Scan data

Scan data show similar trends to time-lapse data, with increasing counts of bears on salt marshes throughout the day (except Katmai) and bimodal patterns on some salmon streams (except Geographic; figures 11 & 12).

Bear abundance in scans during salt marsh use periods was on average 6.07 bears per scan from 06:00-11:59, 3.95 from 12:00-17:59, and 6.45 from 18:00-23:59 at Katmai_SaltMarsh; 12.37 bears per scan from 06:00-11:59, 16.31 from 12:00-17:59, and 21.47 from 18:00-23:59 at Swikshak_SaltMarsh; and 4.87 bears per scan from 06:00-11:59, 5.92 from 12:00-17:59, and 6.75 from 18:00-23:59 at Hallo_SaltMarsh. Human abundance in scans was on average 0 at all times at Katmai_SaltMarsh and Swikshak_SaltMarsh, and was 9.05 from 06:00-11:59, 8.86 from 12:00-17:59, and 5.49 from 18:00-23:59 at Hallo_SaltMarsh (table 2).

Bear abundance in scans during salmon stream use periods was on average 2.98 bears per scan from 06:00-11:59, 2.41 from 12:00-17:59, and 2.87 from 18:00-23:59 at Dakavak_CR; 0 bears per scan from 03:00-05:59, 1.94 from 06:00-11:59, 0.80 from 12:00-17:59, and 1.73 from 18:00-23:59 at Hallo_CR; and 1.75 bears per scan from 06:00-11:59, 1.02 from 12:00-17:59, and 0.74 from 18:00-23:59 at Geographic_CR. Human abundance in scans was 0 for all times at Dakavak_CR; 0 people per scan from 03:00-05:59, 2.45 from 06:00-11:59, 2.78 from 12:00-17:59, and 0.64 from 18:00-23:59 at Hallo_CR; and 11.35 people per scan from 06:00-11:59, 11.17 from 12:00-17:59, and 6.93 from 18:00-23:59 at Geographic_CR (table 2).

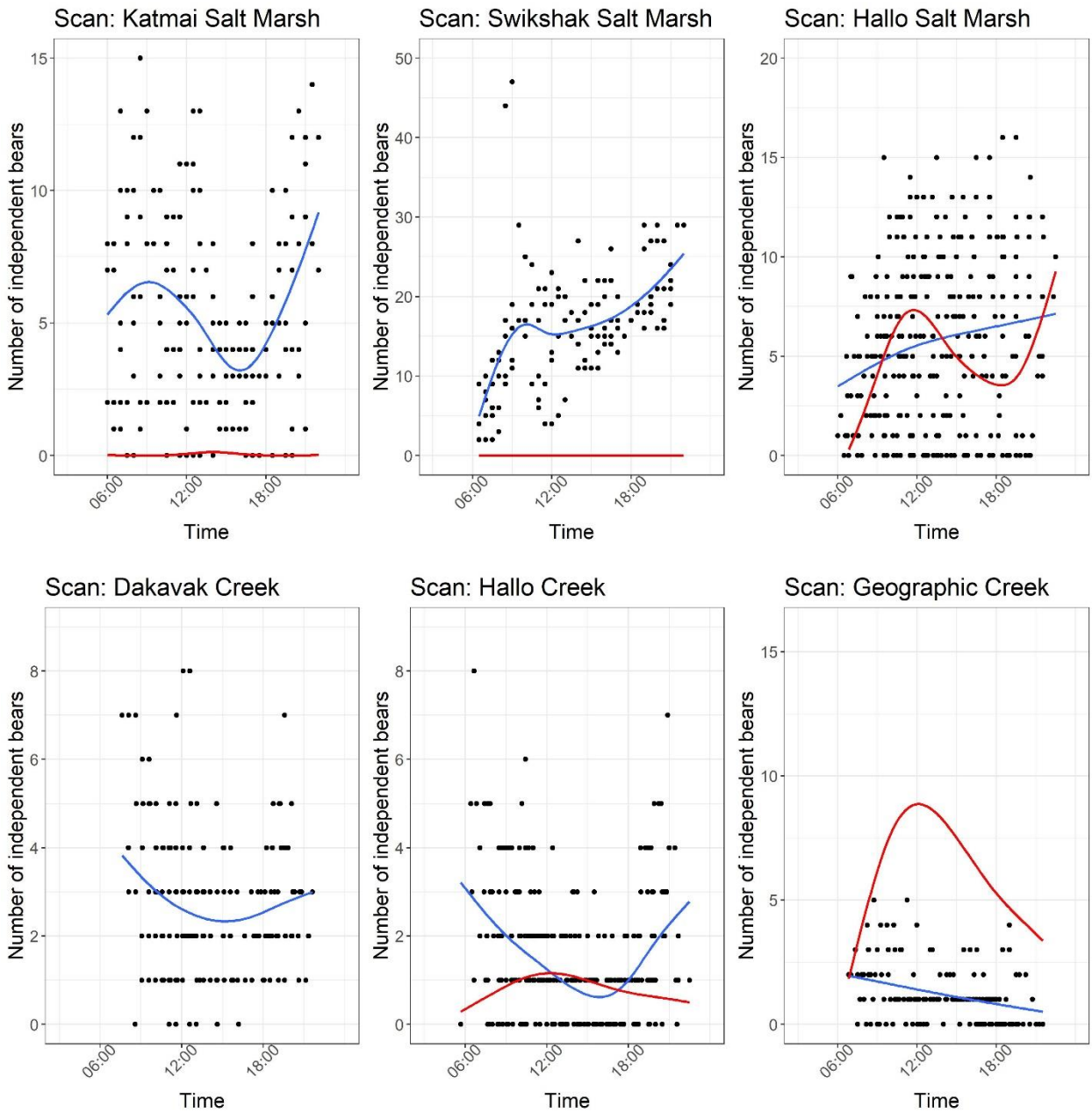


Figure 11. Raw bear count data by time from scan count data (black dots) at salt marsh (top row) and salmon stream (bottom row) sites in Katmai National Park, 2015-2018. Trends in bear counts in blue, human counts in red.

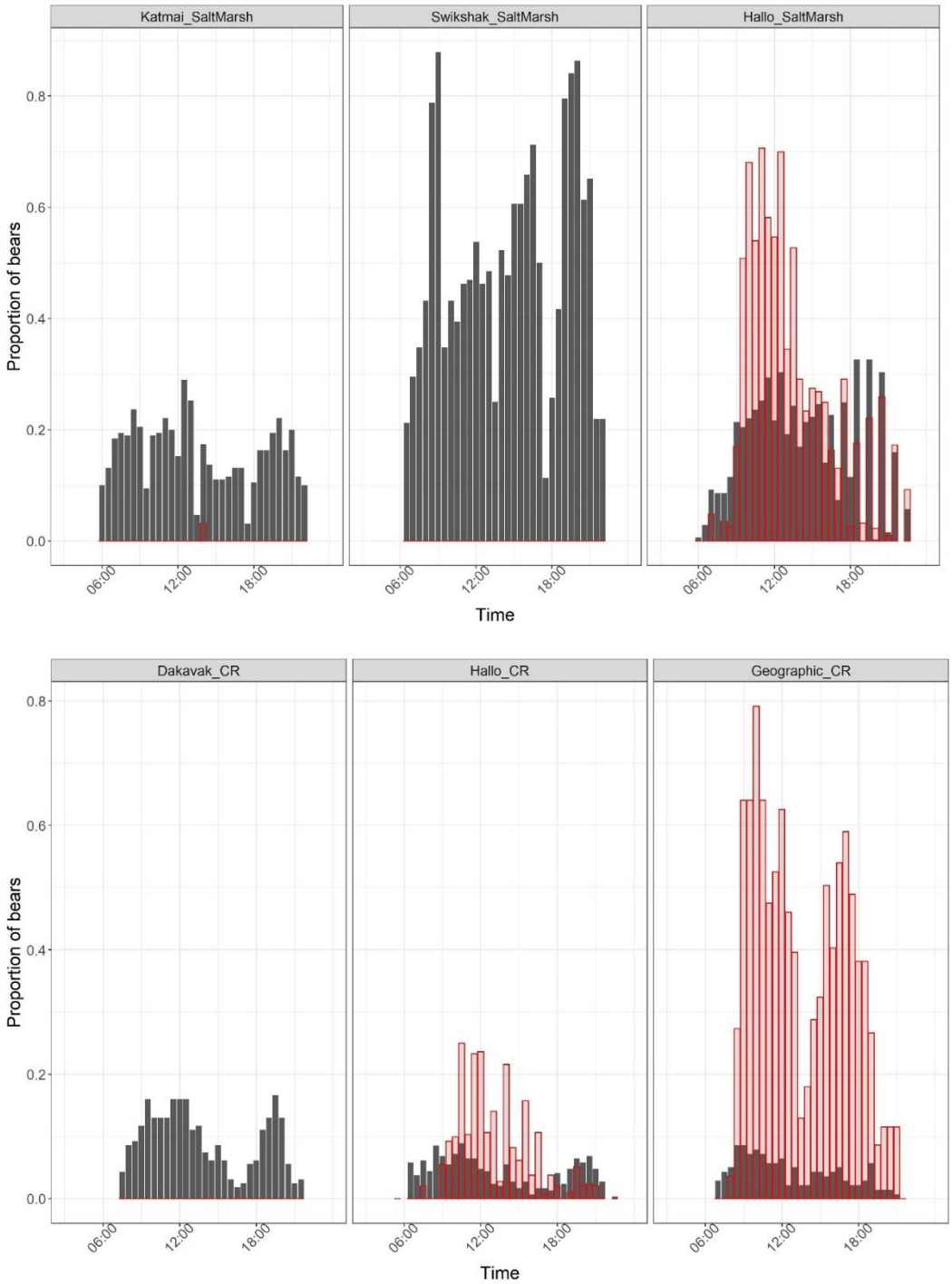


Figure 12. Proportion of bears counted at each time period (i.e., total animals counted at time/total observations during prime use season at that sample location) from scan samples at salt marsh (top row) and salmon stream (bottom row) sites in Katmai National Park, 2015-2018. Bear proportions in black, human proportions in red.

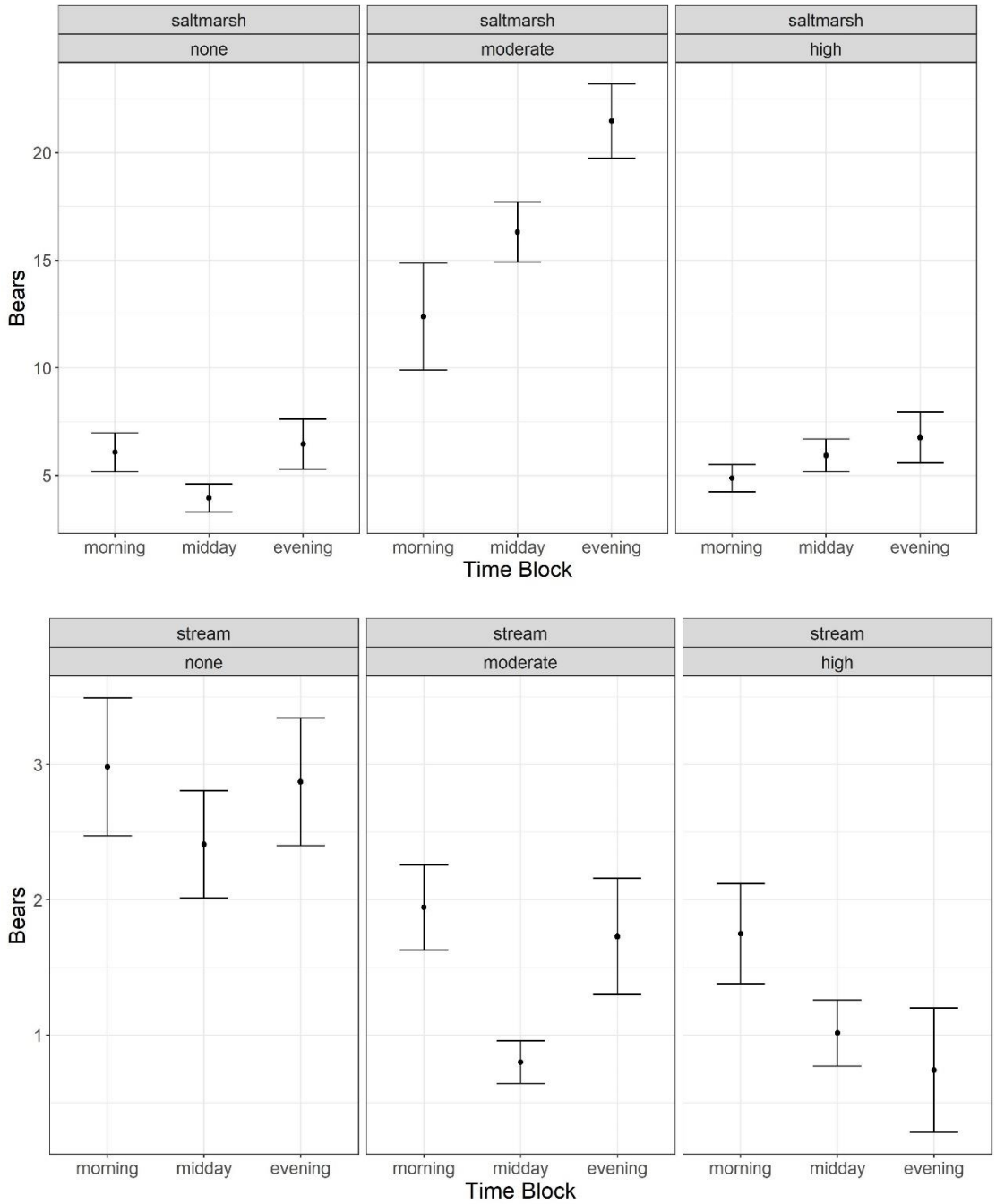


Figure 13. Bear counts (mean ± 95% confidence interval) from scan samples at each salt marsh and salmon stream site by time block (morning: 06:00-11:59, midday: 12:00-17:59, evening: 18:00-23:59) in Katmai National Park, 2007-2018 (top row: Katmai_SaltMarsh, Swikshak_SaltMarsh, Hallo_SaltMarsh; bottom row: Dakavak_CR, Hallo_CR, Geographic_CR).

Table 2. Average number of bears per scan, salt marshes (top) and salmon streams (bottom), Katmai National Park, 2007-2018. Night: 0:00-05:59; morning: 06:00-11:59, midday: 12:00-17:59, evening: 18:00-23:59.

			Bear					People					
scansite	**vis.**	**time.block**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**n**
Katmai_SaltMarsh	none	morning	6.07	3.73	0.46	5.16	6.98	0.00	0.00	0.00	0.00	0.00	67
Katmai_SaltMarsh	none	midday	3.95	2.95	0.33	3.30	4.60	0.07	0.67	0.07	-0.07	0.22	81
Katmai_SaltMarsh	none	evening	6.45	3.75	0.58	5.28	7.62	0.00	0.00	0.00	0.00	0.00	42
Swikshak_SaltMarsh	mod.	morning	12.37	9.10	1.24	9.89	14.85	0.00	0.00	0.00	0.00	0.00	54
Swikshak_SaltMarsh	mod.	midday	16.31	4.81	0.69	14.92	17.71	0.00	0.00	0.00	0.00	0.00	48
Swikshak_SaltMarsh	mod.	evening	21.47	4.64	0.85	19.73	23.20	0.00	0.00	0.00	0.00	0.00	30
Hallo_SaltMarsh	high	morning	4.87	3.65	0.32	4.23	5.51	9.05	12.11	1.07	6.93	11.16	128
Hallo_SaltMarsh	high	midday	5.92	4.37	0.39	5.16	6.69	8.86	10.33	0.91	7.05	10.67	128
Hallo_SaltMarsh	high	evening	6.75	4.46	0.59	5.57	7.94	5.49	7.10	0.94	3.61	7.37	57

			Bear					People					
scansite	**vis.**	**time.block**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**mean**	**sd**	**se**	**low.ci**	**up.ci**	**n**
Dakavak_CR	none	morning	2.98	1.92	0.25	2.47	3.49	0.00	0.00	0.00	0.00	0.00	57
Dakavak_CR	none	midday	2.41	1.61	0.20	2.01	2.80	0.00	0.00	0.00	0.00	0.00	66
Dakavak_CR	none	evening	2.87	1.45	0.23	2.40	3.34	0.00	0.00	0.00	0.00	0.00	39
Hallo_CR	mod.	night	0.00	NA	NA	NA	NA	0.00	NA	NA	NA	NA	1
Hallo_CR	mod.	morning	1.94	1.64	0.16	1.63	2.26	2.45	6.61	0.64	1.18	3.71	107
Hallo_CR	mod.	midday	0.80	0.89	0.08	0.64	0.96	2.78	6.78	0.61	1.58	3.98	125
Hallo_CR	mod.	evening	1.73	1.65	0.21	1.30	2.16	0.64	1.86	0.24	0.16	1.13	59
Geographic_CR	high	morning	1.75	1.33	0.18	1.38	2.12	11.35	9.06	1.26	8.82	13.87	52
Geographic_CR	high	midday	1.02	0.95	0.12	0.77	1.26	11.17	8.79	1.13	8.90	13.44	60
Geographic_CR	high	evening	0.74	1.16	0.22	0.28	1.20	6.93	9.99	1.92	2.97	10.88	27

Discussion

The need to protect animals from the effects of human disturbance is central to wildlife conservation and a primary goal of national parks. We examined how bears use two primary habitats heavily used by bear viewers in Katmai National Park (salt marshes and intertidal salmon streams), in an effort to understand whether human use of bear viewing sites is altering how bears use these habitats. We analyzed time-use patterns of bears on salt marshes and salmon streams at sites with no human visitation, moderate human visitation, and high human visitation. Bears used the two habitats differently: counts of animals on salt marshes gradually increased throughout the day, while counts of animals on salmon streams were higher in the morning and evening and lower midday. The time-

use pattern within each habitat type was not different across sites with differing degrees of human use, suggesting the time-use patterns may result primarily from the resources themselves, rather than human influence. Given that bears use salt marshes and salmon streams differently, management strategies to conserve natural behaviors of bears on the two habitat type should likely differ.

Time-use patterns of bears were consistent across multiple salt marshes, and there was statistical support for the increasing trend in abundance throughout the day. The time-response of bears on salmon streams, however, was more nuanced. The bimodal pattern we observed in plots of raw and proportional counts of bears from time-lapse photos was not supported statistically; the day-standardized counts of bears were not statistically different between time-blocks. Data quality may play a role in what appear to be visible, but not statistical differences. The number of bears observed at Geographic Creek was much higher than the other two salmon stream locations, and trends in time-use may be more difficult to pick up when bear abundance is naturally lower (Quinn et al. 2014). Low salmon abundance could also have led to lower bear abundance and a diminished time-use signal at Dakavak and Hallo creeks during our study. Pink salmon (*Oncorhynchus gorbuscha*), one of the primary prey for bears in coastal Katmai, return in lower abundances in even years than odd years (Heard 1991) and data for Hallo and Dakavak was collected in 2018—an even year. Geographic Creek also had three years of data while Dakavak and Hallo had only one year of time-lapse data. It's possible that with additional data, the signal at Dakavak and Hallo would be more pronounced, as it is in Geographic. Scan data for Hallo, for example, where we collected two years of data, showed more pronounced morning and evening bimodal activity with statistical support for a midday drop in abundance (95% confidence intervals among time blocks did not overlap). Alternatively, it's also possible that the weaker time-use signals seen at Dakavak and Hallo are the expected outcome, but that human use exacerbates the amplitude of the signal in a high-use area like Geographic (Bentley et al. 2014).

Based on evidence from other systems, however, the expectation that all three of our salmon stream sites could have the same bimodal time-use signature is not far-fetched. The relationship of higher morning and evening salmon stream use by bears with low midday use has been seen elsewhere (Quinn et al. 2014, Fischbach and Reynolds 2005; French 2010; Deacy et al. 2019, Warner 1987), including sites where people are not present (Deacy et al. 2019, Fischbach and Reynolds 2005; Warner 1987, Quinn et al. 2014) and across sites with a gradient of human use (Quinn et al. 2014). A previous study at Hallo Bay also found that bears showed the same trends we recorded on salt marshes and salmon streams, even though human visitation was ~1/1000 of what it was during this study. They also found that bear numbers did not differ significantly in the presence and absence of people (French 2007), further suggesting that the time use pattern of low midday bear abundance on intertidal salmon streams may not primarily result from human pressure. Interestingly, many of the same bears that use the Hallo salt marsh also

use the Hallo salmon stream. Those bears experiencing human visitation on salt marshes do not show a midday drop in abundance, but the same bears on the salmon stream do seem to show decreases in abundance midday.

The reason for the difference in time-use patterns between salt marsh and salmon stream habitats are not clear, but variation in foraging efficiency likely plays a role. Some studies report that salmon are more likely to move in the mornings and evenings, with twilight being the most likely signal, not temperature or food availability (Warren and Morbey 2012). Movement during twilight could be related to sun compass orientation (Ueda et al. 2007) or avoidance of visually oriented avian predators (Thorstad et al. 2008), and at our sites bears could be matching the crepuscular patterns of fish movement. Because bears can only fish for salmon at low tides in the sections of stream we studied, we expect that tide plays a role in bear use of the sites. However, if the presence of low tide was the predominant factor affecting bear counts, we might expect a more uniform distribution in bear abundance because the timing of low tide changes regularly from day to day. Tide may still play a role, but maybe one affecting strength rather than presence or absence. Tides appear more pronounced early and late in the day than they are in the middle of the day in coastal Katmai (NOAA tide charts for Nukshak Island, AK). Therefore, the higher highs and lower lows in the mornings and evenings may be a cue that bears are using to guide their fishing behavior. Bears could be using more inland portions of streams that are not affected by tides during midday and using the intertidal portions of the stream more during stronger morning and evening pulses. This seems plausible, as counts of bears on the inland portion of Dakavak Creek were more uniform than counts that we recorded on the intertidal (figure 9).

Physiology of the bears may also play a role in the time-use patterns we observed. The pattern of peak activity around twilight and reduced activity midday is commonly seen in brown bear behavior studies (Kaczensky et al. 2006, Moe et al. 2007), so the expectation of this pattern for bears on salmon streams seems reasonable. In fact, the absence of this pattern on salt marshes should likely be the greater surprise. High protein meals take longer to pass through the bear’s digestive tract than does vegetation (Pritchard and Robbins 1990). Thus, bears may need time for digestion after morning and evening salmon feedings, resulting in low midday and nighttime bear abundance on streams. Salt marshes, in contrast, are constantly available and without the ability to ferment fiber, bears must maximize calories by consuming large quantities of vegetation and passing it quickly to refill their gut (Rode et al. 2001). The need to forage for most of the day may be part of the reason a midday drop is not seen in salt marshes. Personal observation also suggests bears are more likely to sleep in salt marshes than along intertidal salmon streams, so even if bears are taking midday naps in both locations, bears may only be counted during their naps on salt marshes and absent from counts during naps on streams.

This study provided evidence that bears use two important bear viewing habitats differently throughout the day and that understanding the effects of bear viewers on bears may require a habitat-specific lens. We also did not detect an obvious effect of bear viewing in the time-use pattern of bear counts in each habitat, so the pattern in time use of bears may not be the best indicator of whether human disturbance has taken place. Additional data would strengthen the confidence of our findings, however. Additionally, although we've shown what appears to be a bimodal trend in bear use of intertidal salmon streams, other researchers caution against generalizing trends like this to additional sites. Quinn et al. (2014) noted extensive variation in upstream migration patterns among and within salmon species and streams. Furthermore, although we did not detect an obvious effect of human visitation in our study, it is still possible humans are affecting bears in other ways. We urge continued investigation to discover the best ways to assess the impact of visitors on bears in Katmai. Future studies could benefit from including twilight photo data in these analyses to see if the strength of time-use trends improves; additional photos from 2019 and 2020 could be evaluated to determine if they contribute valuable information to models; and sex and age class use of the various sites could be examined to look for changes in the space-use of bears related to human presence.

Acknowledgements

We thank the National Park Service for funding this project and Katmai National Park for logistical support to carry out the work. Invaluable time-lapse data from Katmai Bay, Swikshak Bay, and Geographic Harbor were provided by Katmai National Park. We thank staff at ViQi for their dedication to producing the best possible data for this project.

Literature Cited

Bentley, K. T., D. E. Schindler, T. J. Cline, J. B. Armstrong, D. Macias, L. R. Ciepiela, and R. Hilborn. 2014. Predator avoidance during reproduction: diel movements by spawning sockeye salmon between stream and lake habitats. Journal of Animal Ecology 83:1478–1489.

Fortin, J. K., K. D. Rode, G. V. Hilderbrand, J. Wilder, S. Farley, C. Jorgensen, and B. G. Marcot. 2016. Impacts of Human Recreation on Brown Bears (Ursus arctos): A Review and New Management Tool. D. E. Crocker, editor. PLOS ONE 11:e0141983.

French, H. B. 2007. Effects of bear viewers and photographers on brown bears (Ursus arctos) at Hallo Bay, Katmai National Park and Preserve, Alaska. University of Alaska Fairbanks, Fairbanks, AK.

Frid, A., and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6. <http://www.ecologyandsociety.org/vol6/iss1/art11/inline.html>. Accessed 4 Mar 2017.

Heard, W. R. 1991. Pacific salmon: Life histories. Pages 119–230 *in*. Life history of pink salmon (Oncorhynchus gorbuscha). UBC Press, Vancouver, British Columbia, Canada.

Huffeldt, N. P., and F. R. Merkel. 2013. Remote Time-lapse Photography as a Monitoring Tool for Colonial Breeding Seabirds: A Case Study Using Thick-billed Murres (*Uria lomvia*). Waterbirds 36:330–341.

Jia, Y., E. Shelhamer, J. Donahue, S. Karayev, J. Long, R. Girshick, S. Guadarrama, and T. Darrell. 2014. BVLC/caffe. <https://github.com/BLVC/caffe/tree/master/models/bvlc_reference_caffenet>.

Kaczensky, P., D. Huber, F. Knauer, H. Roth, A. Wagner, and J. Kusak. 2006. Activity patterns of brown bears (Ursus arctos) in Slovenia and Croatia. Journal of Zoology 269:474–485.

Krizhevsky, A., I. Sutskever, and G. E. Hinton. 2017. ImageNet classification with deep convolutional neural networks. Communications of the ACM 60:84–90.

Moe, T. F. M. F., J. K. Kindberg, I. J. Jansson, and J. E. S. E. Swenson. 2007. Importance of diel behaviour when studying habitat selection: examples from female Scandinavian brown bears (Ursus arctos). Canadian Journal of Zoology. <https://cdnsciencepub.com/doi/abs/10.1139/z07-034>. Accessed 23 Dec 2020.

NPS. 1916. The National Park Service Organic Act (16 U.S.C. 1).

Olson, T. L., R. C. Squibb, and B. K. Gilbert. 1998. Brown bear diurnal activity and human use: A comparison of two salmon streams. Ursus 10:547–555.

Pritchard, G. T., and C. T. Robbins. 1990. Digestive and Metabolic Efficiencies of Grizzly and Black Bears. Canadian Journal of Zoology 68:1645–1651.

Quinn, T. P., A. J. Wirsing, B. Smith, C. J. Cunningham, and J. Ching. 2014. Complementary use of motion-activated cameras and unbaited wire snares for DNA sampling reveals diel and seasonal activity patterns of brown bears (*Ursus arctos*) foraging on adult sockeye salmon (*Oncorhynchus nerka*). Canadian Journal of Zoology 92:893–903.

R Core Team. 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rode, K. D., C. T. Robbins, and L. A. Shipley. 2001. Constraints on herbivory by grizzly bears. Oecologia 128:62–71.

Shively, K. J., A. W. Alldredge, and G. E. Phillips. 2005. Elk reproductive response to removal of calving season disturbance by humans. The Journal of Wildlife Management 69:1073–1080.

Skibins, J. C., J. C. Hallo, J. L. Sharp, and R. E. Manning. 2012. Quantifying the Role of Viewing the Denali "Big 5" in Visitor Satisfaction and Awareness: Conservation Implications for Flagship Recognition and Resource Management. Human Dimensions of Wildlife 17:112–128.

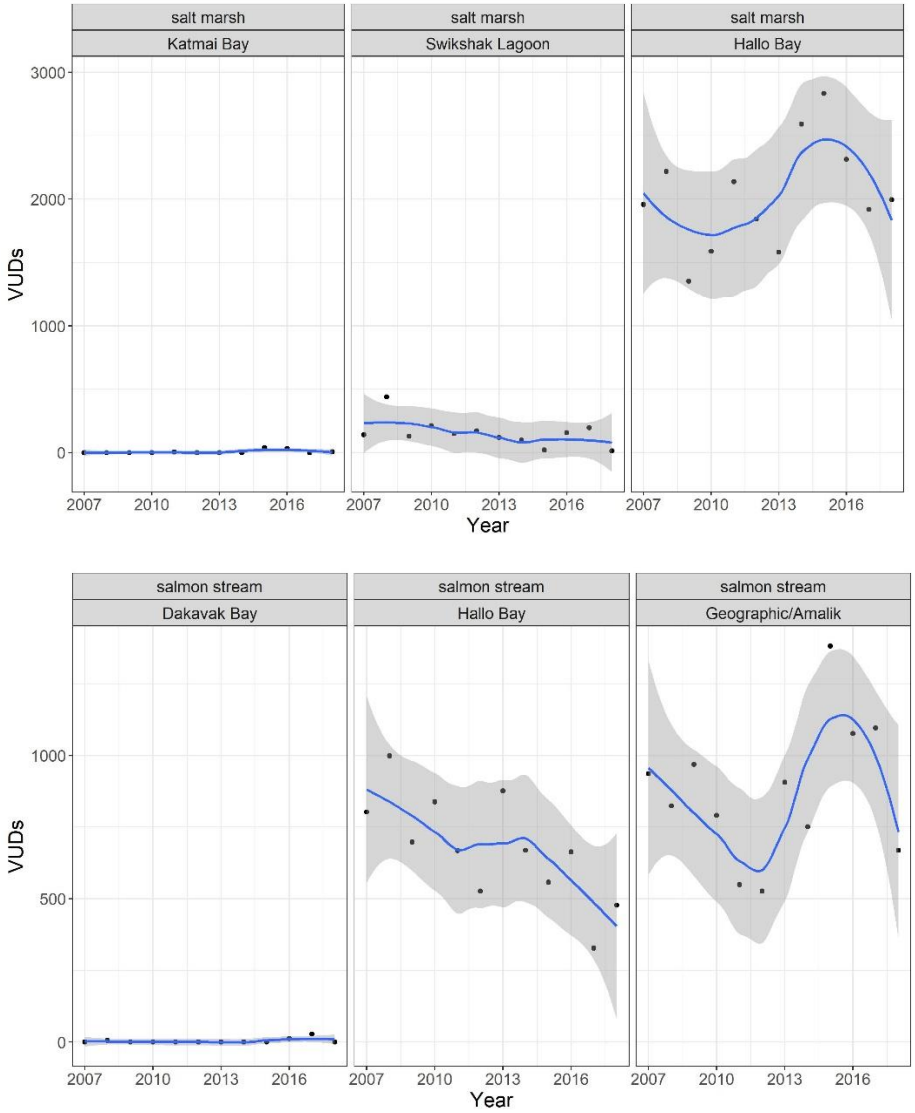
Thorstad, E. B., F. Økland, K. Aarestrup, and T. G. Heggberget. 2008. Factors affecting the within-river spawning migration of Atlantic salmon, with emphasis on human impacts. Reviews in Fish Biology and Fisheries 18:345–371.

Turner, C. 2012. Determining the effectiveness of park management strategies at a coastal brown bear viewing site in Katmai National Park, Alaska. Master's Thesis, Royal Roads University.

Ueda, H., Y. Yamamoto, and H. Hino. 2007. Physiological Mechanisms of Homing Ability in Sockeye Salmon: From Behavior to Molecules Using a Lacustrine Model. 13.

Warren, M. A., and Y. E. Morbey. 2012. Migration timing of female kokanee salmon Oncorhynchus nerka: diel patterns and effects of maturation state. Journal of Fish Biology 81:1234–1247.

Appendix A. CUA data used to determine visitation level at each site



Appendix B. Time-lapse camera housing and tripod setup