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A Geospatial Analysis of Safety and Risk Perception in the Buffalo National River

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Abstract

In 1972, the Buffalo River in Arkansas became America's First National River. Since then, the Buffalo National River has become a beloved recreational retreat for locals and visitors alike. The Buffalo National River is home to incredibly scenic views and host to many outdoor activities, among them hiking and floating. As with any confluence of nature and humans, there is great risk involved in all aspects of the park. Between 2011 and 2017, a total of 140 search and rescue missions were carried out. Some were resolved easily, but more serious accidents were not unheard of.

Risk perception studies are a vital resource used by authority figures such as the National Park Service (NPS) to strategize public education efforts and begin to mitigate risk. This study of risk perception strove to shed light on how visitors perceive risk in the context of the Buffalo National River. A one-page survey was administered to 80 park visitors, the results of which were compared to NPS records on actual search and rescue events that took place in the park from 2011 to 2017. It was found that though survey participants as a whole largely marked areas of risk correctly, certain demographic groups were less aware of potential risk. Suggestions for targeted educational efforts and potential risk mitigation strategies were made using the results of this study.

Keywords: risk perception, Buffalo National River, Arkansas, hazards, risk, search and rescue

Acknowledgements

Having just written an entire thesis, I have very little desire to write too much more. However, thanks are in order, so I will keep this short and sweet. First of all, thank you to my incredible professors at the University of Arkansas. I met and learned from so many amazing individuals during my six years in Fayetteville. Thank you to my committee, Fiona and Dr. Tullis, for being willing to go above and beyond for me, and especially thank you to Tom for all your feedback, lessons, and gab sessions.

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Chapter One: Introduction

In the summer of 1978, a young man named Michael Mandel made a series of visits to Arkansas' Buffalo National River. He was a camp counselor for the St. Louis Jewish Community Center Association at the time and first visited the Buffalo to scout the area out as a potential place to bring young campers. On his second trip to the Buffalo, with campers in tow, he asked a National Park Service ranger where he should take the kids swimming. The ranger replied that they should go to a swimming hole known as Mud Cave, adding "That's where everybody goes. That's where we recommend you go" (Mandel v. US, 1986). While this trip passed without incident, Mandel was not so lucky the next time he visited Mud Cave. On August 1, 1978, Michael Mandel dove headfirst into the Buffalo River. Unbeknownst to him, a large rock was submerged some four to five feet below the water in the exact spot where he dove. Mandel collided with the rock, suffering a broken neck that resulted in quadriplegia.

In the years following the accident, Mandel filed suit against the United States seeking reparations for damages. After appealing, he won the case in 1986 on the grounds that "the National Park Service had failed to exercise ordinary care in not warning Mandel of the presence of submerged rocks in the Buffalo River" (Mandel v. US, 1986). Though the court found him responsible for a small percentage of the accident, they ruled that the ranger's recommendation of the Mud Cave swimming hole without warning of possible risks coupled with the fact that no caution signs were posted in the area "were the proximate cause of Mandel's injuries" (Mandel v. US, 1986). He was awarded nearly one million dollars in reparations.

Today, perhaps because of unfortunate stories such as Mandel's, the National Park Service does its best to provide more than just "ordinary care." The Buffalo National River website has pages of information regarding potential hazards and how to stay safe. Safety signs can be found standing guard at every front country river access, and detailed warning fliers are posted at all trailheads. The Park Service makes it clear that "you are responsible for your own safety" by putting that phrase in large bold letters at the top of their safety information page

("Safety," 2017). They warn of thunderstorms, wildlife, water, bluff, and cave hazards. They also have a list of things you should do to "Be Prepared. Plan Ahead." that instructs visitors to "tell someone where you are going," "know your limits and prepare," and "wear your life jacket," among others ("Preventative Search and Rescue," 2019). On the website, each bullet point is followed by a paragraph explaining in further detail what these mean and what visitors should do to prevent issues. The park service also has a news and alerts section on their website where they can warn visitors of hazards such as rising river levels or bad weather. In addition to all of these warnings and guidelines, fliers warning of risks can be found on every information board within the park, and warning signs are a frequent sight.

Figure 1.1: Warning signs located at the Ponca Bridge and the Indian Rockhouse trailhead (Personal photo).

Despite all this, accidents still happen. In May of 2011 following a series of flood announcements, a National Park Service news article was released titled "Search underway for Newton County Man in Buffalo National River" ("Search Underway," 2011). By the next day, the follow-up article was titled "Search Continues for Drowning Victim" ("Search Continues," 2011).

River conditions were at flood stage when the man tried to swim across the river. The writer of the article advised readers that "all visitors, including area residents, are strongly encouraged to be as informed as possible about the risks of using the river, whether for swimming, canoeing, kayaking, or other activities, and understand that there is always the potential for accidents, even in low water conditions" ("Search Underway," 2011).

As with anywhere in the world, risk is present in the Buffalo National River. It is a fantastic destination with incredible opportunities for outdoor recreation, but it is still a wild river in a remote area. Recreationists need to be aware and prepared when participating in an activity in the Buffalo National River, as they do in any situation life may throw at them. The National Park Service has plenty of information available on its website for visitors to arm themselves with before an outing in the Buffalo. And yet, incidents requiring search and rescue continue to occur. Search and rescue (SAR) events are costly and time-consuming for the park service, not to mention tremendously unpleasant for the victim. An assessment of risk perception can be a good first step to lessening or preventing the occurrence of search and rescue events. If visitors perceive risk differently than it actually is, it can lead to inadvertent risk-taking and potential SARs. Education plays an important role in risk mitigation, and the results of this study will provide a basis for the National Park Service to better inform their visitors on possible risks and how to avoid them.

Chapter Two: Literature Review

The study of risk perception relies heavily on a knowledge of psychology. What is going on in people's brains that make them perceive risk differently? Why does something appear risky to some, and entirely risk-free to others? Why do experts perceive risk differently than laypeople? These are some of the questions that the field of risk perception strives to answer in order to better understand how to manage risk, and in turn how the National Park Service can use risk perception studies to educate park visitors.

2-1 – Defining Risk

The concept of 'risk' is a bit of a complex word to define. Because 'risk' as a concept is a human construct created to help us deal with dangers, it can be hard to nail down one single definition that everyone can agree on (Slovic & Weber, 2002, p. 4). Despite the intangibility and elusiveness of the subject, researchers have still endeavored to create an actual definition for the word. Marcus Schmidt asserted that "risk is always the risk of something … to someone" (Schmidt, 2004, p. 3). Interestingly, Schmidt was forced to use the word 'risk' in his definition of the word 'risk.' Though simple and to the point, does this definition truly explain 'risk?' Slovic and Weber believed that, because risk is a mental concept, "it does not exist 'out there,' independent of our minds and cultures" (Slovic & Weber, 2002, p. 4). They argued that "although [the] dangers are real, there is no such thing as 'real risk' or 'objective risk'" (Slovic & Weber, 2002, p. 4). Perhaps Slovic and Weber's assertation that 'risk' exists only in the mind explains why Schmidt was unable to define 'risk' without using the word itself.

Slovic and Weber (2002) listed out some of the ways the word 'risk' is used by researchers rather than trying to define it. Their examples summarize the ways in which we can use the word:

- Risk as a hazard. Example: “Which risks should we rank?”
- Risk as [a] probability. Example: “What is the risk of getting AIDS from an infected needle”
- Risk as [a] consequence. Example: “What is the risk of letting your parking meter expire?” (Answer: “Getting a ticket.”)
- Risk as potential adversity or threat. Example: “How great is the risk of riding a motorcycle?”

(Slovic & Weber, 2002, p. 4)

Some researchers, on the other hand, were able to create a slightly more tangible definition of ‘risk’ by relating it to their definition of ‘hazard.’ It is important to note that, though similar, ‘hazard’ and ‘risk’ are not the same thing. Keith Smith (2013), stated that a hazard is

> “a potential threat to humans and their welfare arising from a dangerous phenomenon or substance that may cause loss of life, injury, property damage and other community losses or damage” and that, therefore, a ‘risk’ is “the combination of the probability of a hazardous event and its negative consequences”
>
> (Keith Smith, 2013, p. 11)

‘Hazard’ is a term that can be used to refer to any number of dangers and, according to Smith’s definition, all hazards *have* risk. This idea was supported in Slovic, Fischhoff, and Lichtenstein’s article “Characterizing Perceived Risk” (1985) which asserts that ‘hazards’ are “threats to humans and what they value,” while an explanation of ‘risk’ involves “a wide range of cognitive dimensions,” in addition to “probabilities of experiencing harm” (p. 91).

These discrepancies in definitions and the researcher's ability to conclusively define the word ‘risk' quite possibly stem from the very issue many risk analysis experts have devoted their careers to studying: perception. As previously stated, the idea of ‘risk' is a construct of the mind. It does not yet have a universal definition because every human being perceives it differently. How a person perceives something is dependent upon their knowledge, experience, and the context available to them, so no two perceptions are the same (Jung, 1959).

2-2 – A History of Risk Assessment and its Evolution Towards Risk Perception

Because perception of risk is unique to each person, it is a challenge to make broad classifications. Despite this difficulty, humans have been assessing risk in some form for centuries. Records of rudimentary risk assessments based on signs from the gods date back to ancient times, but more modern researchers in the last half-century worked hard to quantify risk perception in a more scientific manner (Cutter, 1994, p. 33). Risk assessments began by looking at the risk some large natural disaster could pose to infrastructure and quickly evolved to include a study of how those risks were perceived by the humans in their way. Today, assessments of the perception of risk can include anything from the traditional large natural hazard to smaller risks that affect more specific populations.

Even before more recent academic attempts to assess risk perception, the United States government had already performed an early exploit into the analysis of risk perception in the 1940s. This research occurred during World War II and was intended to assess the best way to avoid a hysterical public reaction to wartime events (Cutter, 1994, p. 21). The wartime research strove to find answers to questions such as "What types of people are susceptible to panic and what types can be counted on for leadership in an emergency?" as well as "What techniques are effective in reducing or controlling fear?" (Cutter, 1994, p. 21). Although this government assessment did not specifically label their study using the phrase ‘risk perception,' it involved similar research questions and goals to that of the future academic field of study by the same name.

Even though the U.S. government dabbled in risk perception as a result of World War II, the academic side of research had yet to seriously consider the subject. Originally, investigations involving risk focused almost entirely on assessing natural hazards and their effect on property and productivity, such as the difficulties a flooded river would create for practical uses such as navigation or agriculture (Cutter, 1994, p. 5). These assessments produced results aimed at the mitigation of risks to infrastructure, though they still included

some human element. For example, White (1964) performed a cost-benefit analysis on a selection of towns lying in a flood zone. White evaluated the impact of the financial cost of a flood versus the financial benefits of remaining in the flood plain regardless of the risk (White, 1964). Though his results focused specifically on the financial consequences of flood risk in his 1964 impact analysis, White noticed that his findings were very much influenced by perceptions, be it the perceptions of laypeople or authority figure subjects. He noted that people's understanding of the financial risk and reaction to the physical risk posed by floods varied by location, education, and their past experiences with floods (Cutter, 1994, p. 9). He also acknowledged (as cited in Cutter, 1994) that "people oftentimes returned to the use of land which had been severely damaged by floods, being aware of the consequences of a recurrence and facing probably disaster of either a personal or financial character from such recurrence (p. 8).

This concept of consciously choosing to return to an area with a high risk of another devastating flood must have puzzled and intrigued White. In a later article reflecting on his early career work, he acknowledged encountering what he called “one of the truly difficult problems of social science: the relationship, if any, between verbalized attitudes and actual behavior” (as cited in Cutter, 1994, p. 9). Though in his initial flood assessment he found that people said they should avoid areas of high risk, he also found that they repeatedly put themselves back in harm’s way for seemingly little financial benefit. But why? White was not the only researcher curious about the impact that people’s differing perceptions had on risk assessments and behavior. The next research trend in risk studies following White’s 1964 flood assessment endeavored to answer that question.

2-3 – A Review of Early Risk Perception Research

In the mid-1970s, risk perception pioneers Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein began researching the most effective way to record and measure risk perception in order to establish a standard. Slovic, in his article "The Perception of Risk," stated that

> "the elusive and hard to manage qualities of today's hazards have forced the creation of a new intellectual discipline called risk assessment, designed to aid in identifying, characterizing, and quantifying risk"
>
> (as cited in Cutter, 1994, p. 155).

This official categorization of risk assessment as a field of study paved the way for future research.

Slovic, Fischhoff, and Lichtenstein strove to answer the question "how safe is safe enough?" (Fischhoff, Slovic, & Lichtenstein, 1978). In their research, an assortment of risks was specifically selected for their study including items or activities such as general aviation, contraceptives, home appliances, and nuclear power, among others (Fischhoff et al., 1978, Table 1). Participants were asked to rate actions in such a way as to compare the risk they would be required to take to the benefit they would receive for taking the risk. It was found that the greater the benefit, the more willing participants were to take a risk (Fischhoff et al, 1978). In another experiment, Slovic et al (1985) included more participants and more actions to rate. This study found that laypeople and experts "agree generally on risk qualities but not on attitude towards risk" (Slovic et al, 1985, p. 91). This could be interpreted to mean that while both experts and laypeople understand that an activity poses a risk, they disagree as to how it should be approached. Slovic and Weber (2002) sum this dichotomy up nicely by stating that "experts appear to see riskiness as synonymous with expected annual mortality," while laypeople tend to see it more as risk to themselves or to future generations.

According to Slovic et al (1982), risk can be grouped into two factors: whether a risk is known or unknown, and whether it is controllable or uncontrollable. In a slightly later study, these variables were named Unknown Risk and Dread Risk, respectively (Slovic et al., 1985). If

a risk scores low on the Unknown factor, they tend to be “familiar, voluntary activities whose risks are well known to science and to those exposed” (Slovic et al., 1985). People are much more accepting of risks that do not score highly on either scale. The more known and controllable a risk is, the more willing people are to take that risk. Conversely, the more unknown and uncontrollable a risk is, the more people are inclined to avoid said risk.

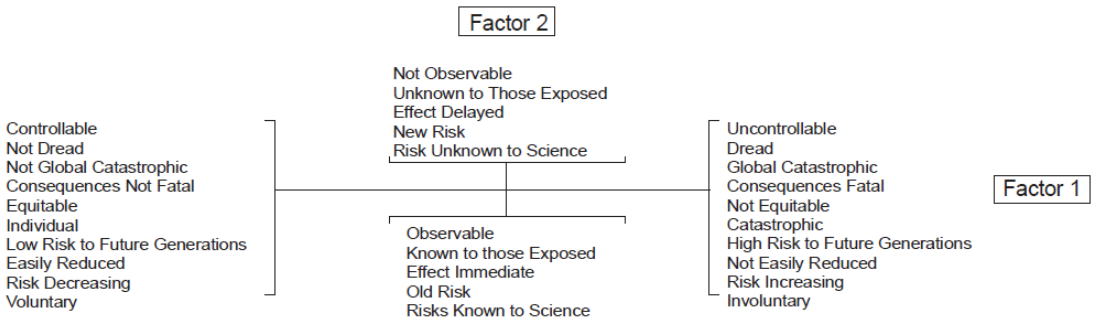


Figure 2.1: Diagram defining unknown risk and dread risk (Slovic & Weber, 2002, p. 11).

Markus Schmidt's "Investigating Risk Perception: A Short Introduction" (2004) is a useful overview of all of the previous information gleaned from experiments and papers done by Slovic, Fischhoff, and Lichtenstein (1982; 1985). Schmidt focused on the perception of risk in general, rather than the perception of specific risks. Schmidt examined risk perception as a function of multiple components, some of which are voluntariness, controllability, causation (natural vs. manmade), and the potential benefit. If an action is not voluntary, it will generally result in backlash from the public. Therefore, policymakers have a difficult time convincing or forcing laypeople to take a risk. Conversely, "people tend to accept risks that are voluntarily chosen even if those risks are approximately 1000 times as risky as accepted involuntary risks" (Schmidt, 2004, p. 4). Similarly, if a person does not feel in control of a situation, the risk will seem much higher.

Figure 2.2: Image of a rock climber scaling a sheer bluff in the Richland Creek area of the Buffalo National River (Photo: Tyler Casey).

Generally, people estimate their own risk to be lower than the average risk and may put themselves in harm's way simply because they think they are in control (Schmidt, 2004, p. 5). Schmidt also stated that there is a double standard in risk perception depending on the cause of the hazard – whether the risk was natural or manmade. People are more inclined to accept their fate in the face of natural hazards since they have no power to stop the hazard. However, if damage occurs that is thought to have been caused by man, those deemed responsible – such as policy-makers – can face backlash for not doing enough to prevent the damage. In addition, Schmidt reiterated that people are more willing to take a risk if the benefit is worth more than the associated compulsory risk (Schmidt, 2004, p. 8). Similar to Slovic, Schmidt also analyzed risk on a known-unknown, controllable-uncontrollable scale. Schmidt agreed that if a risk is perceived as both uncontrollable and unknown, then it is often overestimated (Schmidt, 2004, p. 12).

After understanding a layperson's perception of risk, policymakers must be able to communicate their stance to the public. Fischhoff's article on the communication of risk detailed the thought process of an expert. At first the expert might believe that if they manage to get the numbers right then the public will believe them. Then, if that does not work, surely the public will understand the risk if the expert explains the numbers, and so on. Fischhoff argued that truthful and clear representation of the numbers is absolutely necessary for the public to understand the risk, but that it is equally important to avoid bombarding them with too much information (Fischhoff, Bostrom, & Quadrel, 1993).

Keith Smith, in his textbook *Environmental Hazards* outlined some of the same principles as Slovic, Fischhoff, and Schmidt. He argued that "in terms of disaster reduction, the main practical goal [of risk analysis] is *risk management*" (Keith Smith, 2013). Policymakers must understand the thinking of laypeople and be able to anticipate their reactions in order to better manage potential hazardous situations. Smith conceded that "there is no fully objective approach to risk decisions and … quantitative analysis is best viewed as a partial, rather than a complete, function" (Keith Smith, 2013, p. 74). Policymakers should understand this in order to better understand the public's reactions. Smith's book did explain risk perception, but it focuses more on risks within the environment. Specifically, "the extreme, often rapid-onset, events that directly threaten human life, property, and other assets" (Keith Smith, 2013, p. 4).

In general, studying risk perception should "aid policy-makers by improving communication between them and the lay public, anticipating public responses to experiences and events, and directing educational efforts" (Slovic et al., 1982, p. 83). Slovic also stated that risks are more appealing to the public if there is a greater benefit to taking that risk (Slovic et al., 1982). Benefits in the Buffalo National River (BNR) could include a beautiful view, an interesting hike, or an exhilarating float. The National Park Service (NPS) could benefit from a knowledge of which risks visitors consider to be high, where they believe the risks are, and how different people react to risks. If policymakers do not understand the public's possible actions and

reasoning, it is virtually impossible to create a useful strategy with which to manage that risk (Slovic et al., 1982).

In 2005, a study of the perception of risk among earthquake survivors in Agadir, Morocco was done. Using a short questionnaire, participants were surveyed to determine their demographics, if they knew anything about the 1960 earthquake, if they were afraid of earthquakes, if they believed that buildings in Agadir were safe, and if and when they believed another earthquake might occur (Paradise, 2005). Paradise found that young age correlated with the belief that buildings are safe, women were generally more afraid of earthquakes while men were generally less afraid, and that television ownership likely contributed to a subject's knowledge of earthquakes. Most importantly, Paradise's survey revealed that education correlated with an understanding that an earthquake could be imminent in the region. Those with higher levels of education understood that Agadir is situated in a seismically active region, while those with less education were more likely to assert that "Allah protected those who were devout so that worrying and planning for earthquakes was unwarranted" (Paradise, 2005, p. 178). This risk perception survey revealed that the government of Agadir needed to target their earthquake awareness efforts towards those who possessed the least amount of education. If these citizens cannot be made aware of the seriousness that is earthquake preparedness, they could be in danger should another large quake occur.

This type of risk study is a combination of the original topic (natural hazards) and the newer topic (perception) in the field of risk assessment. Paradise utilized perception as a way of assessing the risk posed by earthquakes to the population of Agadir. His results provided the government of Agadir with important information that they could then use to mitigate risk and keep their citizens safer. This concept can be applied to risk within National Parks, as well.

While the Buffalo, as with anywhere, has a chance for sudden or large environmental hazards, the majority of common risks in the National River are more individualized. People could fall off a bluff, get injured while hiking, be thrown from their horse, go under while

swimming, or undergo a multitude of other hazards. Because these hazards tend to affect smaller groups of people, they rarely make headlines and can be lesser known to the general public. In addition, people tend to overestimate their ability to do an activity, sometimes ignoring warning signs from either their body or the park itself. These factors, among others, can combine to form risky situations, making the study of the more human aspects of risk incredibly relevant.

2-4 – Impact of the Cost of Search and Rescue Events in National Parks

The National Park System has been called “America’s Best Idea” for good reason. Since the Organic Act creating the National Park Service (NPS) in 1916, the NPS has obtained just over 85,000,000 acres of land that has been preserved “for the enjoyment … of future generations” (“Organic Act,” 1916). In 2018, over 318,000,000 people enjoyed recreational visits to National Parks (“National Park Service IRMA Portal”). The NPS has a duty to keep every one of them safe, and this is quite an arduous task. Unfortunately, though the NPS has grown to accommodate massive amounts of land holdings, impressively high visitor counts, and even higher levels of responsibility – be it to their visitors, the wildlife, or the land – their budget has not grown proportionately and remains tight. Search and rescue (SAR) missions use up a large and unnecessary chunk of their already limited budget.

Travis Heggie is one of the risk analysis field’s links to the National Park Service. He studies search and rescue trends and the cost of these missions to the NPS. Because of the great risk to life and limb, as well as to the NPS budget, Heggie argued that it is even more important to “study and quantify the problems tourists encounter” (Heggie, 2009b, p. 23). By analyzing the trends in SAR, Heggie was able to determine that daytime hiking had the overall highest need for rescue missions and that typically males aged 20-29 were the victims (Heggie, 2009b, p. 26). If the NPS understands where and how accidents requiring SAR generally occur, it could use the opportunity to better communicate to visitors why they should avoid said risks

and how they could be avoided. In addition to saving lives, the NPS could also save money, which is crucial with their ever-tighter budget (Heggie, 2009b, p. 26). Though SAR missions are expensive, “the NPS policy states that the saving of human lives will take precedence over all other management actions” (Heggie, 2009a, p. 244). Between the years of 1992 and 2007, SAR missions have cost the NPS over fifty-eight million dollars (Heggie, 2009a, p. 245). Lowering costs can be considered a large incentive for the NPS to promote preventative education.

Figure 2.3: Lower Falls on the Yellowstone River in Yellowstone National Park (NPS & Frank).

As previously stated, Heggie’s analysis of SAR trends found that hiking required the most rescues. On the other hand, mountaineering and climbing required comparatively few rescues. Why then, do visitors generally assume mountaineering or climbing to be a greater risk than hiking? This could be due to any number of factors that could be discerned by using the psychological viewpoint of risk analysis and perception. Heggie claims that perception of risk

can be influenced by the media and other social factors. Heggie's findings stated that "contrary to media reports and popular belief, fatalities in US-NPS units are not due to exotic causes such as bears or other wildlife attacks." Instead, the most fatalities inside National Parks occur as a result of motor vehicle crashes (Heggie, Heggie, and Kliewer, 2008, p. 408). In Heggie's own words, the findings of his study

> "show an opportunity for a chronically understaffed and underfunded NPS to develop fatality prevention strategies in a small number of NPS units with the potential to prevent a high number of fatalities"
>
> (Heggie et al., 2008, p. 409).

2-5 – Further Risk Perception Studies in the Context of National Parks

When you think of a camping trip, what comes to mind? Is it a cheery fire surrounded by smiling people making s'mores? Or do you picture threatening shadows lurking in the dark? Jamie A. Snyder (2017) investigated people's fear of crime and perceptions of risk while at National Park Service campgrounds. Running off the assumption that an "individual may have lower perceived risk and fear of crime while on vacation than when at home," Snyder distributed surveys to campers in one Florida national park and two Florida state parks (2017). Her surveys utilized Likert scaling to determine first the participant's fear of crime and then how they perceived the risk that they would become a victim. While surveying subjects, Snyder frequently encountered comments indicating that "crime was not something that many people considered an issue while camping" (Snyder, 2017, p. 415). The survey results found that both fear of crime and perception of risk were low, though "those that perceived their risk of victimization as higher were one and a half times more likely to report fear of crime" (Snyder, 2017, p. 314). Though perceived risk and fear are not the same, they seem indicative of each other.

While camping, most people are in a 'vacation' mindset. When on vacation one does not tend to worry about the mundane things you might think about at home, evidenced by the fact that "respondents were significantly more like to say they were somewhat or very likely to

experience crime in their neighborhood (29%) compared to camping (9%)" (Snyder, 2017, p. 315). This 'vacation' mindset could influence other visitors to National Parks in addition to campers. While people may be aware of risks present in and around their homes, they may be ignorant of those surrounding them while hiking, floating, or swimming. If that is the case, visitors could benefit from further efforts to educate them about these risks.

In the case of Cape Breton Highlands National Park in Canada (CBHNPC), additional attempts to educate visitors on how to minimize risk seem to have been successful. In 2009, a visitor to CBHNPC was attacked and killed by a coyote. Since then, the park increased its efforts to educate visitors about coyotes with the goal of minimizing visitor-coyote interactions. Surveys were administered to park visitors, staff, and residents who lived near the park in 2011 and 2012, two and three years following the incident (Sponarski, 2015).

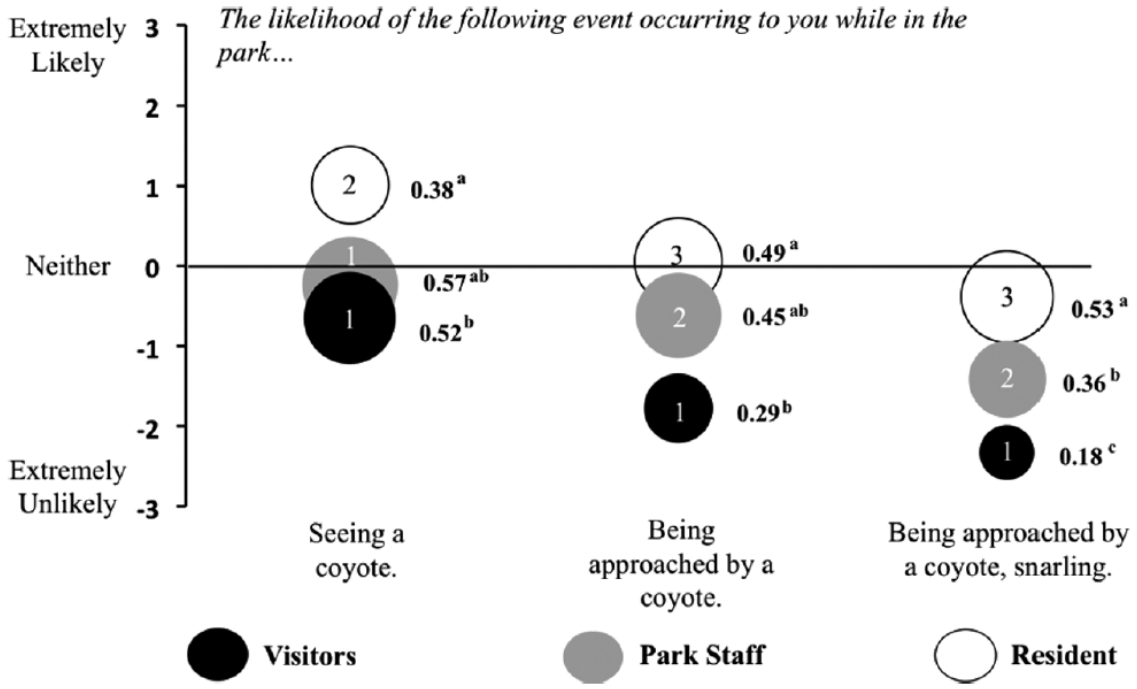


Figure 2.4: Participants perception of risk of seeing a coyote, being approached by a coyote, and being approached by a snarling coyote (Sponarski, 2015, p. 728). Visitors are more confident than the other two groups that they will not encounter a coyote, making their risk perception lower.

The goal of the study was to assess attitudinal differences between the three groups toward coyotes, with the hypothesis that visitors would be the least negative towards coyotes. This turned out to be true, with the results showing that “visitors generally held positive attitudes, reported less fear, described a low perceived likelihood of interacting with a coyote, and felt in perceived control of coming into contact with a coyote while visiting CBHNPC” (Sponarski, 2015, p. 729). Conversely, residents of the area felt more fear, “high perceived likelihood of interacting with a with a coyote, and felt not in perceived control of coming into contact with a coyote while visiting CBHNPC” (Sponarski, 2015, p. 729). Further discussion attributed this dichotomy in attitudes to experience and education. Residents are stationary in the area, while visitors are voluntary at CBHNPC for a relatively short amount of time. Visitors may have greater experience with the outdoors or wildlife than residents, and residents may be less likely to visit CBHNPC, where information on coyotes is readily available. Sponarski argues that “visitors are more exposed to coyote-related safety messages, which explain how to act and how to prevent coyotes from approaching” (Sponarski, 2015, p. 730). Though this thesis has little to do with coyotes, Sponarski’s study is a good example of the effectiveness educational efforts can have on visitors to a park.

When a person is involved in an accident requiring a search and rescue mission, someone or something is to blame. It could be the victim’s own incompetence or ignorance, or possibly because of a slippery rock or a tricky trail. The blame can even be assigned to the park where the accident took place, as we saw in the case of Mandel versus the United States (1986). Laura N. Rickard’s article “Accidents and Accountability: Perceptions of Unintentional Injury in Three National Parks” (2014) looked at how and where blame is assigned following an incident. Rickard stated that “in a national park, the cause of injury can be perceived as internal (a hiker’s clumsiness) or external (a slippery trail). The cause may be perceived as controllable (e.g., the hiker did not carry needed equipment but could have chosen to) or uncontrollable (e.g., rainy weather)” (2014, p. 89).

Rickard's theory is very similar to Slovic and Fischhoff's method of measuring risks on a sliding scale with axis labeled as known/unknown or controllable/uncontrollable (Slovic et al., 1982). The determination of the cause of an accident as internal or external, controllable or uncontrollable can depend on the perception of the observer. If an observer believes the victim is similar to themselves, "they may be more motivated to attribute the accident to external factors," thus avoiding blaming themselves should they get into a similar incident (Rickard, 2014, p. 90). This mindset also contributes to the "propensity for individuals to see themselves as less susceptible to risk-induced outcomes than those around them" (Rickard, 2014, p. 90). This can lead to national park visitors maintaining a lower individual perception of risk, even in the face of high risk levels.

The study results showed that visitors believed that the majority of incidents in the NPS can be blamed on external causal attribution"(Rickard, 2014). This means they do not take responsibility for their own actions and "may consider the event to be random, and therefore not preventable" (Rickard, 2014, p. 100). If this is correct, visitors should be educated further about the risks inherent in national parks and how to prevent them. However, it is possible that employees who believe that the visitors are the sole cause of their own accidents could think it unnecessary and neglect to inform visitors of preventative information (Rickard, 2014, p. 100). Based on her study, Rickard argued that a key aspect of changing attitudes about risk lies in emphasizing that "visitor accidents are not random, but rather that individuals have considerable control over certain aspects of their park visit, such as seeking information about park facilities and carrying certain supplies" (Rickard, 2014, p. 102). The application of Rickard's findings and suggestions to National Park Service risk education efforts could be an important step in mitigation.

Figure 2.5: Vernal Falls on the Merced River in Yosemite, reachable by way of the Mist Trail. Photo from the NPS archive ("Vernal Falls," NPS).

Almost opposite of Rickard, Deborah C. Girasek performed research in 2015 studying the motivations behind why hikers approached a hazardous river in Yosemite National Park. Rather than assessing the aftereffects of an accident, Girasek strove to understand what led people to put themselves in a risky situation. In Yosemite, the popular Mist Trail follows the roaring Merced River upstream for views of the Vernal and Nevada Waterfalls. An average of 3000 hikers per summer use this trail, and the Merced River is responsible for 83% of Yosemite's water-related deaths (Girasek, 2015, p. 110). The proximity of the dangerous river to the busy hiking trail raised a red flag for Yosemite's Preventative Search and Rescue team, leading them to partner with Girasek to conduct this study in an effort to minimize the risk to visitors of Yosemite National Park.

Over the summer of 2013, Girasek, her study team, and a trained preventative search and rescue NPS staff member conducted surveys at two sites on the Mist Trail near the Merced River – a footbridge crossing the river and a scenic viewpoint at the top of Vernal Falls. Potential

participants were approached only if they entered the pre-determined “risk zones,” which have been highlighted in yellow in Figure 2.6 (Girasek, 2015, p. 111). The study questionnaire recorded demographics in addition to “questions on familiarity with the trail, type of hike (day vs overnight), whether the respondent received information about the hike before setting out, as well as the source and type of information they had received” (Girasek, 2015, p. 111).

Figure 2.6: Participants in Girasek’s study were surveyed after entering one of two “risk zones,” highlighted here in yellow (Girasek, 2015, p. 111).

Girasek found that “a majority of survey respondents reported having decided spontaneously to approach the river when they arrived at that point on the trail” (Girasek, 2015, p. 112). Of these, the main reasons for doing so were ‘to look at the scenery,’ ‘to cool off,’ ‘to rest,’ ‘to take a picture,’ or ‘to have their picture taken’ (Girasek, 2015, p. 113). These reasons for going into a risk zone are all relatively innocent and generally do not reflect knowledge of the true potential danger present in those areas. In fact, “ninety-two per cent of hikers observed at each location reported feeling either ‘safe’ or ‘very safe’” (Girasek, 2015, p. 113). Girasek argued that this could be due to confusion of what is and is not allowed in the section of the Merced River near the Mist Trail since elsewhere in Yosemite the Merced River’s flow is more gentle and visitors can enjoy unrestricted access. The survey results showed that 95% of respondents had received information about the Mist Trail hike, but “only 38% indicated that

they had received guidance to 'stay out of the river'" (Girasek, 2015, p. 112). Though visitors may not have received a verbal warning, Girasek observed "No Swimming" and "Danger" signs near the risk zones, as well as others warning visitors to "stay back from the slippery rocks at the water's edge" (Girasek, 2015, p. 114). She acknowledged that "it is quite possible that the park's existing efforts are sufficient for the majority of trail users," but still postulated that "perhaps it should be standard protocol that visitors asking questions [at the Visitor Center] about the Mist Trail be warned about the river's dangers" (Girasek, 2015, p. 114). In response to visitor's other motivations behind entering a risk zone, Girasek suggested testing the usefulness of misters to help hikers cool off as a replacement for the temptingly cool river water and "'selfie' locations that are set up at a safe distance from water hazards" (Girasek, 2015, p. 114). A smaller park like the Buffalo National River may not necessarily require designated safe 'selfie' locations, but any park can benefit from knowledge of why visitors are inclined to put themselves in risky situations.

At this time, no other studies of risk perception in the Buffalo National River are known to the author, but similar studies have been conducted elsewhere in Arkansas. The closest study to this one, both geographically and theoretically, is Laura Ahrens' "Recreational Risk Assessment using Geospatial Analyses on Beaver Lake, Arkansas" (2014). In it, Ahrens utilized a questionnaire to survey Beaver Lake's authority figures on their perception of risk on the lake. Members of the Arkansas Game & Fish Commission, the Army Corps of Engineers, and the Benton, Carroll, and Washington County Police Departments were all asked to participate in the study. Survey participants were asked to provide basic demographic data, as well as answer questions regarding accidents on Beaver Lake (Ahrens, 2014, p. 39). Ahrens used a series of maps to visually compare the locations and quantity of past accidents to the locations and quantities perceived by the five authority groups.

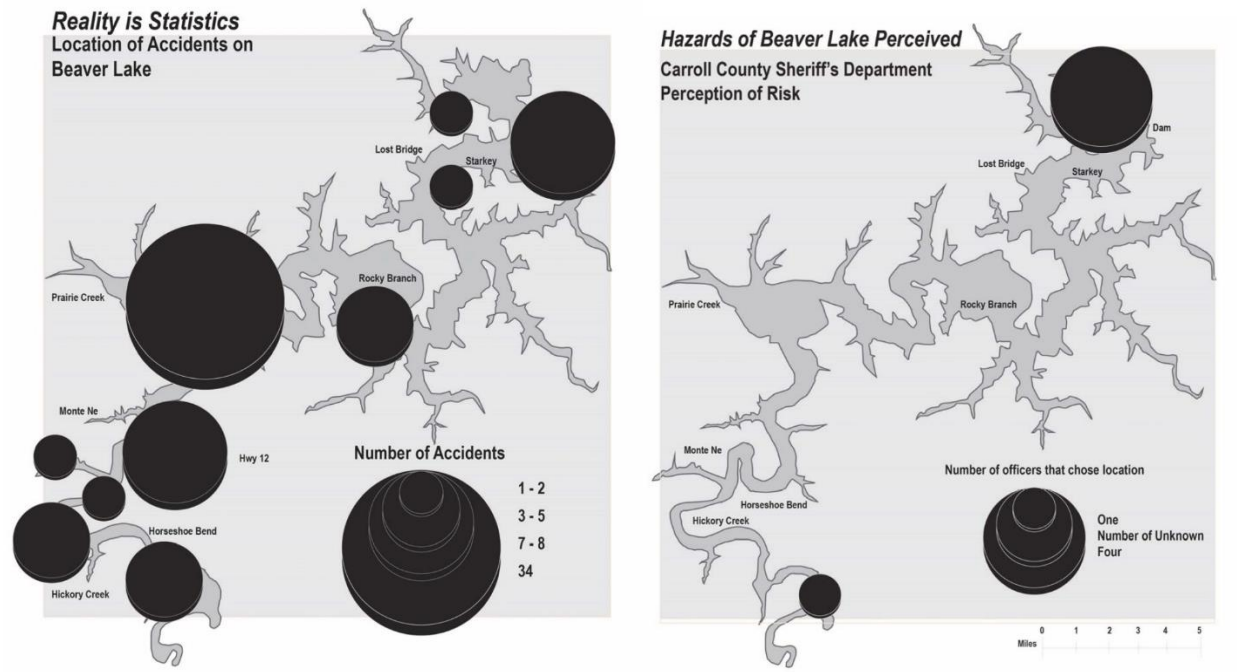


Figure 2.7: Left – map depicting the location and quantity of accidents on Beaver Lake nine-year average as recorded by the Game and Fish Commission (Ahrens, 2014, p. 68). Right – Carroll County Sheriff Department's perceived location of and number of accidents (Ahrens, 2014, p. 69).

Ahrens' study of risk perceptions on Beaver Lake revealed that there was indeed a knowledge gap between the perceived locations and causes of accidents and the actual statistics. Historical accident data revealed that the majority of accidents on Beaver Lake were caused by inexperience and inattention, both tied for first with 22 incidents each. Ahrens found that 42% of the survey participants perceived alcohol as the number one cause of accidents, but other participants simultaneously essentially had no idea what could cause accidents on the lake, with 41% of respondents stating that there was no cause (Ahrens, 2014, p. 49). Though her findings are undermined by a small sample size, they are nonetheless important. Visitors to Beaver Lake count on local agencies to patrol the lake and keep it safe. If authority figures such as Ahrens's study participants do not understand major causes of accidents within their jurisdiction, they will be unable to effectively communicate safety information to the public.

In addition, Ahrens found that 25% of agency employees believed that accidents occurred the most frequently at Prairie Creek, when in reality “most accidents occurred in the Rogers area or near the Highway 12 Bridge” (Ahrens, 2014, p. 78). These sections of the lake are all fairly far away from one another, meaning that if an agency mainly patrols Prairie Creek because they believe it to be the most dangerous area, they might run the risk of a lengthy emergency response time or even miss an opportunity to save a life at the other areas. While Ahrens’ assessment was rather limited in scope, the general idea of applying geographic methods to risk perception data in order to mitigate the risk of accidents is extremely applicable to the Buffalo National River.

2-6 – Studies Relating to the Buffalo National River

As previously discussed, there is a multitude of studies relating to risk perception that have contributed to the formation of this study. However, all of these articles, theses, and dissertations have failed to utilize the Buffalo National River as a study site. Many have included other land and parks controlled by the National Park Service in their studies but, as far as the author knows, there have been no previous studies on risk perception in the Buffalo. Though America’s First National River lacks a risk perception study, it has been the focus of numerous other research projects.

The Buffalo River area is home to a huge array of flora and fauna. Studies have been done assessing and monitoring the health of those species for years. Examples include “Species Richness, Distribution, and Relative Abundance of Freshwater Mussels of the Buffalo National River, Arkansas” by M. Matthews which documented 64 groups of mussels and found that they had a mean density of 6.9 individuals per meter squared and “Proportionality of Population Descriptors of Helminth Infections of Smallmouth Bass from the Buffalo National River” by James J. Daly Sr. (Matthews, 2009, p. 113; Daly Sr. & Wagner, 2018). The National Park Service also routinely produces reports on native species, such as their “Long-term

Aquatic Invertebrate Monitoring at Buffalo National River, Arkansas" (Bowles et al., 2017). This particular paper assessed the effects of water quality and other factors largely out of the NPS's control on aquatic species present within the park boundaries.

Figure 2.8: Elk, one of the many species of fauna that call the park home, enjoying the shade of a lone tree near Ponca, Arkansas (Personal photo, 2019).

The geology of the area is also of particular intrigue to researchers. Michael Chenoweth's 1997 thesis "The Spatial Distribution and Morphometric Analysis of Dolines, Buffalo National River, Newton County, Arkansas" sought to document the location of and determine contributing factors in the formation of sinkholes. More recently, Ashlon Leonard strove to solve the mystery of the source of Margaret White Springs on the Buffalo River – an

interesting spring near an area where the river's flow is lost to groundwater in the dry summer months (2018).

Besides natural resources, tourists and recreationists are an important part of the Buffalo National River. In 2007, Ryan Smith studied the differences in backgrounds of people floating the Buffalo and how that might affect their trip planning and tendencies (R. Smith, 2007). James E. Johnson found in the early 1990s that 9.2% of the estimated 192,348 floaters on the Buffalo River were anglers and that their harvest rates of smallmouth bass were low and likely did not impact the population (1995, p. 82).

This is only a small sample of the numerous studies that have been conducted involving the Buffalo National River. Generally, it appears that researchers choose to study the region's bountiful natural resources, be it related to water, wildlife, or geology. Visitors are studied, too, but it seems the majority of those revolve around topics such as tourism or history. Studying all aspects of the Buffalo National River can only better it.

2-7 – Summary of Literature Review

Studies of risk perception and their resulting recommendations and educational benefits have succeeded in reducing visitor risk in various National Parks, as well as supported the National Park Service in their attempt to bridge the gap between preserving nature and allowing everyone to enjoy it safely. Previous studies such as the ones discussed in this chapter all form a meaningful foundation on which to create a study of risk perception on the Buffalo National River. To ensure a useful result is achieved from a new study, each prior article should be taken into consideration. This study of risk perception will attempt to build upon everything that has come before it by combining the psychological insight of risk perception pioneers Slovic, Fischhoff, and Schmidt with the technical data analysis done by Heggie, the environmental perspectives of Keith Smith and Paradise, the spatial analysis by Ahrens, and the NPS concentration exhibited by Girasek, Rickard, and Snyder.

Chapter Three: Site of Study

Figure 3.1: View of the Buffalo River on a foggy day ("Bluff Shrouded in Fog," NPS & Fondriest).

The Buffalo River is a beautiful, free-flowing stream located in North Central Arkansas. The region features rugged terrain with steep hills and renowned bluffs, as well as a few scattered lowland fields. Founded in 1972, the Buffalo National River has become a treasured destination for outdoor recreation. Before becoming America's first National River, the Buffalo experienced a long and rich past.

3-1 – Geology

The area that is now known as the Buffalo National River was completely covered by an ancient tropical sea for most of the Paleozoic period (Paradise, 2010). Geologic features visible

in the park today are evidence of this in the form of fossils, rock types, and ages. Crinoids were once aquatic animals related to starfish that resembled tall flowers, but now they have become the Buffalo River's most plentiful type of fossil (Ken Smith, 2018, p. 38). As these and other sea creatures lived and died, their accumulated excretions and skeletons contributed to the creation of multiple limestone layers. The Buffalo area also includes an abundance of sandstone, which was formed from ancient sandy beaches or other deposits of sand as continental seas transgressed and regressed (Ken Smith, 2018, p. 8).

Figure 3.2: Image of rocks with crinoid fossils and a penny for scale (Ken Smith, 2018, p. 55).

The oldest exposed rock layer in the Buffalo River area is Ordovician (480 my), which can be seen nearest the river level. The newest rock was deposited about 300 million years before present and can be seen at the very top of the surrounding mountains (Ken Smith, 2018, p. 7). Total deposition of all rock layers took somewhere around 180 million years to complete

(Ken Smith, 2018, p. 11). In addition, a collision between the Earth's tectonic plates caused the area to compress and gradually uplift, resulting in the higher elevations of the Ozark Plateau.

These factors created something of a blank canvas, setting the stage for the Buffalo River to erode and downcut the landscape into what we see today. The Buffalo River Valley, as well as the rest of the Ozark Plateau, was carved by the eroding forces of moving water and wind (Ken Smith, 2018, p. 22). Over millions of years, the river cut as much as 1,200 feet through the rock (Ken Smith, 2018, p. 22). Its tributaries carved their way through the plateau as well, resulting in the mountainous, rugged terrain defined by an entrenched plateau.

Figure 3.3: A view of the Buffalo River Valley with Big Bluff in the distance ("Buffalo River & Big Bluff," NPS).

While water, wind, and weathering created the features visible on the surface, it was only water that formed a myriad of caves underneath. Within the Buffalo National River boundary, there are over 740 caves, shelters, and karst features documented today (Personal

correspondence with Kayla Sapkota of the Cave Research Foundation, 2019). Researchers working in conjunction with the park service are still discovering, monitoring, and documenting caves and features in the park. A landscape dominated by limestone can easily be dissolved by groundwater, creating caverns by mobilizing microscopic bits of rock in each drop of water out and away from the cave. The presence of water in caves can also contribute to the formation of spectacular speleothems such as stalactites, stalagmites, flowstone, or helictites. These impressive and often rare formations add to the uniqueness of the Buffalo River area.

Figure 3.4: Left – A glittering flowstone: just one example of water's incredible underground handiwork (Personal photo). Right – The author, a volunteer with the Ozark Operations of the Cave Research Foundation (working in conjunction with the NPS), takes a break from surveying an Ozark cave to pose by a hibernating pipistrelle bat (Personal photo).

3-2 – Human Occupation

The first period of human presence in the Buffalo River area was postulated to be the Paleoindian Period, which spans from 10,000 BC to 8,000 BC, though there is "little or no

evidence of permanent occupation” in these early years (Catton, 2008). In the years that followed, bluff shelter caves were frequently used as temporary seasonal settlements, and the first appearance of domesticated farming was in the late Archaic period (7,000 BC to 500 BC). Artifacts such as stone tools, arrowheads, pottery shards, and preserved organics have been found in numerous sites throughout the area. Indian Rockhouse, in the lower Buffalo, is a popular hiking destination and a good example of such archaeological sites. Native Americans resided in the Buffalo River valley until the 1830s, when an 1828 treaty went into effect and forced the tribes further west (“People,” 2017).

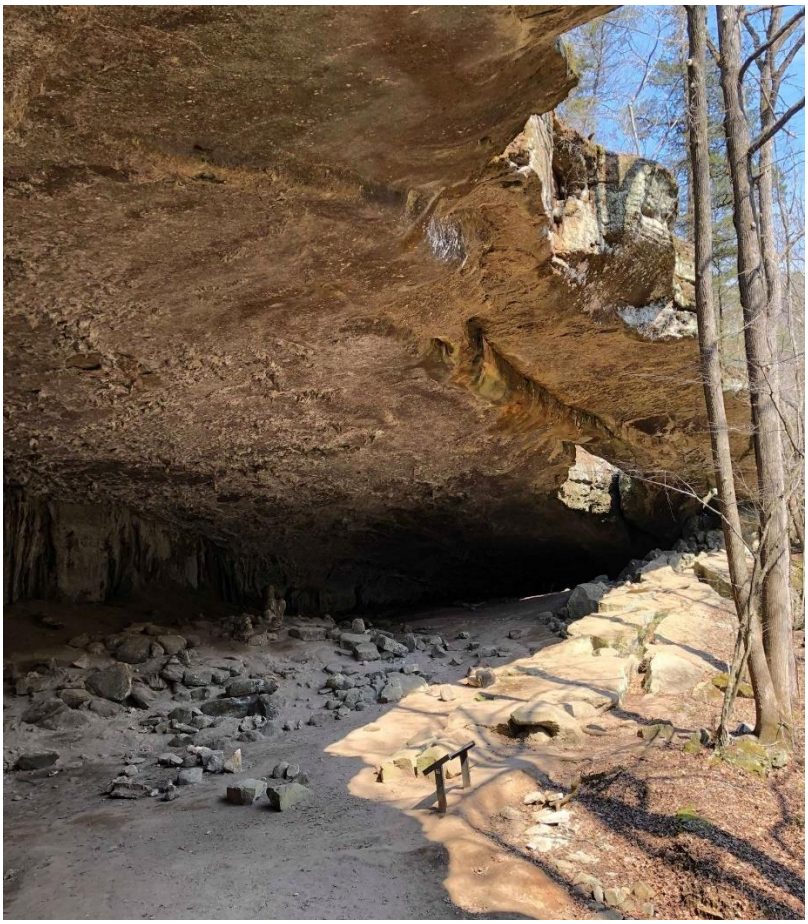


Figure 3.5: Indian Rockhouse, photograph courtesy of NPS (T. Fondriest photographer, NPS)

The first European settlers arrived in the area in the late 1820s (“People,” 2017).

Because they needed to grow their own food, these early settlers first claimed the flat fertile land nearest the river. A 1840s government land survey revealed that “the most densely settled area was along the middle Buffalo… [and] there was perhaps about as much total acreage in cleared fields on the Buffalo’s tributary creeks as along the river” (Catton, 2008, p. 61). The Homestead Act of 1862 allowed for easier access to legal land acquisition, so the less desirable land further away from the river was slowly claimed as well over time.

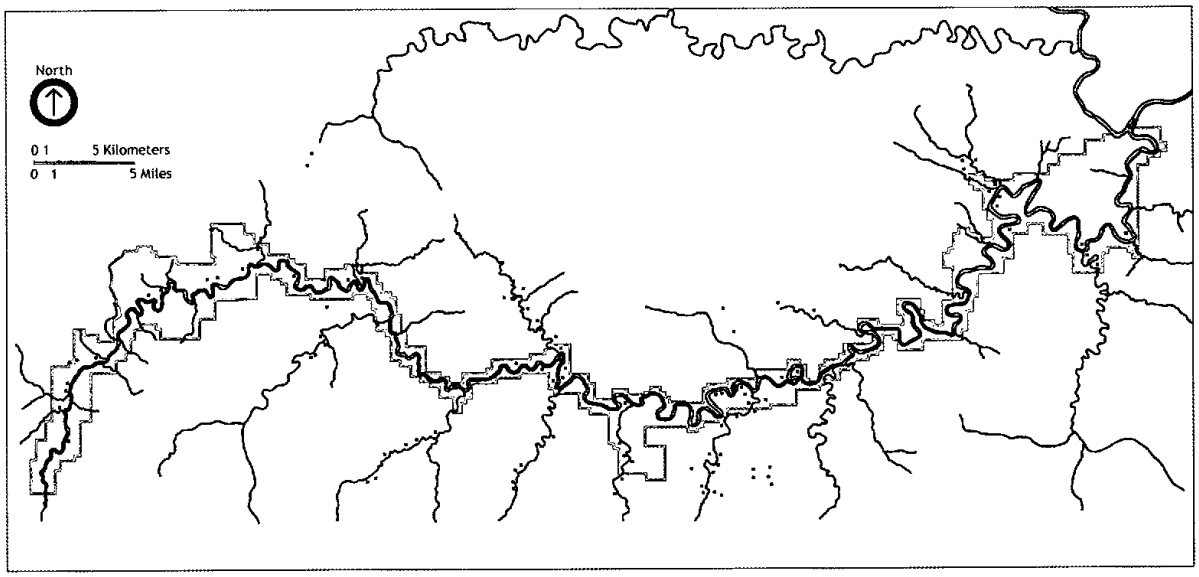


Figure 3.6: Map of Settlements, 1843 – 1848. One dot represents one settled field (Catton, 2008, p. 63).

By the turn of the 20th century, land in the Buffalo River area was nearly entirely claimed by timber companies and homesteaders. As a result of this emerging population, small settlements developed with stores and churches connecting them socially and roads to connect them physically. Many of these communities remained essentially isolated until the turn of the century, containing only a few useful buildings and a sparsely distributed population. Few ever made it to a proper ‘town’ status. Homesteaders in this area maintained a largely agrarian economy, earning a sparse living out of the rocky soil and hilly landscape.

Communities possessing industry, such as mining opportunities, were exceptions. Rush, located in the lower Buffalo, became a booming mine town after the discovery of zinc ore in the 1890s. In 1898, the Morning Star Mining Company opened an operation in Rush, allowing the town to eventually attract a population far greater than that of the other Buffalo River communities (Catton, 2008, p. 179). During the bustle of World War I, Rush offered residents urban amenities such as “restaurants, bakeries, saloons, hotels, and dance halls” (Catton, 2008, p. 181). Eventually, the Great Depression hit and this previously lively mining town never recovered. Evidence of past settlements such as that at Rush can be seen in the form of foundations, crumbling rock fences, and the occasional rickety shed when hiking or floating in the park.

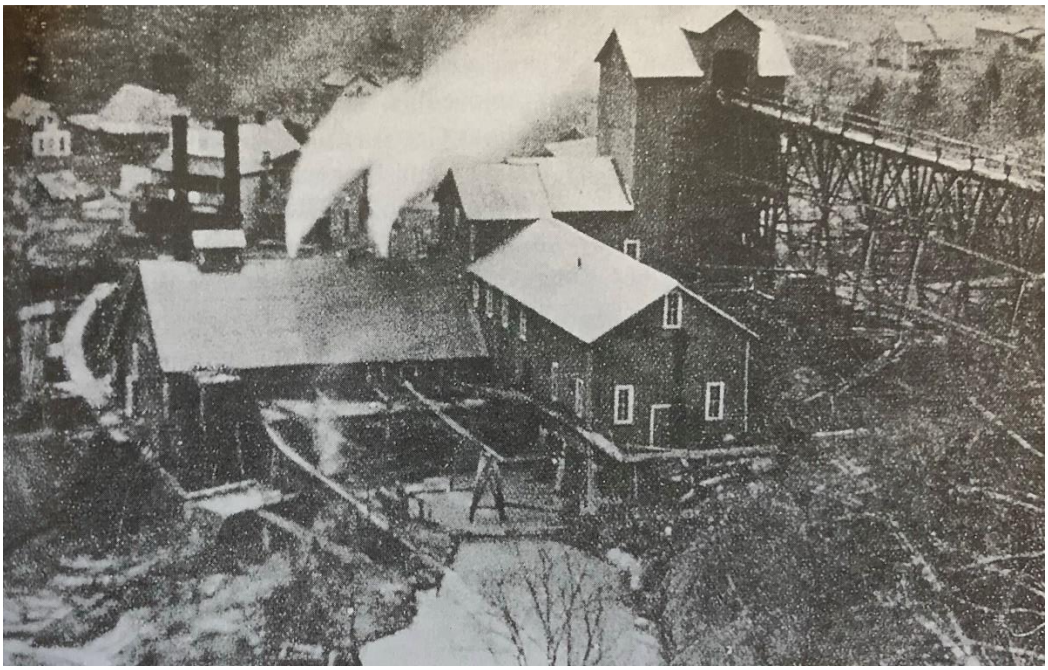


Figure 3.7: Morning Star Mine in Rush, circa 1916 (Ken Smith, 2018, p. 429).

3-3 – Transportation: Trails, Roads, and Railroads

In the early days of settlement in the Buffalo River area, there was only one main wagon trail (Catton, 2008, p. 166). It followed the winding river along its flat bottomlands, and there was

little access to the higher elevations. Homesteaders in the 19th century created crude wagon paths through the area by chopping down trees just enough so that a wagon could pass over the tops of the stumps (Catton, 2008, p. 164). These unfunded roads were initially narrow, rocky, ribbons cut through the forest that hugged the sides of hills, snaking their way up and down valleys, and frequently crisscrossed the river. River crossings were dangerous due to high water levels after rains, and travel between communities was tough, lengthy, and could take days. Still, this was an improvement upon the earlier networks of foot and horse trails.

Figure 3.8: The second bridge to span the Buffalo River, pictured above, was built at Carver and completed around 1916 (Ken Smith, 2018, p. 101).

Though the roads began to improve slightly, before the 1920s the Buffalo River still had no bridges. Commercial ferries were the easiest method of fording the river, the oldest of which was founded in the 1870s. This was Grinder's Ferry, and it was located where the Highway 65

bridge now stands (Catton, 2008, p. 169). The first bridge spanning the Buffalo River was built in 1913 at Pruitt, and by the 1930s the Buffalo boasted five total bridges.

In 1903, the Buffalo area finally gained access to railroads. In these days before cars, the nearby railroad meant an economic boom for poorer, rural communities. Though the rail line connecting the Arkansas towns of Harrison and Leslie offered some prosperity to the Buffalo River area, it was not long-lived or widespread. The Buffalo River "meanders for 150 miles across a straight-line distance of less than 60 miles" from East to West, and this North-South railroad line only crossed the river at one point (Catton, 2008, p. 1). While it did contribute to the mining industry in Rush and to the establishment of a new town at Gilbert, the middle and upper Buffalo areas remained geographically isolated.

This problematic transportation situation persisted well into the Twentieth Century. The terrain surrounding the Buffalo River made mobility difficult, contributing to the relative geographic isolation of its communities. In 1920, prominent geographer Carl Sauer stated that the area "was served by two almost separate road systems: one followed the ridge tops and the other traced the valley bottoms. The two systems were tenuously joined by 'rough and often badly washed side roads'" (Catton, 2008, p. 167-168). These disconnected routes allowed for parallel travel, but passage between the two remained inaccessible. It wasn't until 1927 that the Buffalo River area enjoyed access to a state-funded two-lane highway system. A solution existed in the creation of Highway 7 through Harrison and Jasper, though it was still a bumpy unpaved road with "hairpin turns" and hills that could burn up your brakes (Catton, 2008, p. 168). The coming of World War II allowed for infrastructure improvements all over the nation, including in the Buffalo River area. Most major roads were regraded and surfaced with gravel in the 1940s, and by 1961 all highways in the area were finally paved (Catton, 2008, p. 252). The better road conditions and newfound access led to increased road use and increased traffic to the Buffalo River area.

3-4 – Journey to America's First National River

Following the improvement of roads and, consequently, access to the area, the Buffalo River began experiencing more frequent recreational use. It was suddenly much easier for city dwellers to drive down and spend a day experiencing what the Buffalo had to offer. This phenomenon was not unique to the Buffalo River. The car has been argued to be the driving stimulus for the tourism industry across the nation. In fact, "the automobile fairly launched the state park movement" (Catton, 2008, p. 222). Many people began to take advantage of the Buffalo River State Park, located in the area we now know as Buffalo Point on the lower river. The park, which was established in 1938 and developed by the Civilian Conservation Corps as part of President Roosevelt's New Deal, enjoyed 25,000 visitors per year by 1953 (Catton, 2008, p. 226 & 231).

Likewise, better roads impacted the actual inhabitants of the Buffalo River area. Life near the Buffalo was finally more comfortable, and residents no longer found themselves as geographically isolated. The ease of travel by car had succeeded in "destroying or powerfully undermining even the most stalwart breastworks of isolation" (Catton, 2008, p. 254). They could simply drive into town for work or to enjoy the amenities of a larger community. In addition, by the 1960s electricity had at last reached the area (Ken Smith, 2018, p. 102). By 1968 the region even had its very own theme park called Dogpatch USA. It was based on the comic strip Li'l Abner and, in addition to a roller coaster, fishing, and a train ride, "featured Ozark musicians and craftspeople, resulting in an awkward mix of blatant hillbilly stereotyping and cultural celebration" (Jackson, 2011, p. 281). The park, which attracted an impressive 300,000 visitors in its first season, was located on Highway 7 between the Buffalo River and the town of Harrison, Arkansas (Blevins, 2002, p. 264). Though the population remained sparse and Dogpatch USA did little to dispel unfavorable stereotypes, the Buffalo River area was quickly becoming less and less of an isolated 'backwoods' location, threatening the relatively untouched natural condition of the river.

World War II had thrown the entire nation into a frenzy of industry, and the communities in the Buffalo River area benefitted from this economic upturn in part by eventually enjoying new roads and electricity. However, this wartime boom was not entirely a good thing for the region. In 1943, the Army Corps of Engineers completed construction of Norfolk Dam, flooding 30,700 acres of land to be able to produce cheap electricity (Catton, 2008, p. 236). Following the war, the Corps set their sights on building infrastructure throughout America for flood control. They surveyed many rivers for potential dam sites, including the Buffalo. In addition to flood control, these dams would supposedly provide energy, a water supply, recreation, and revenue to the counties they were situated in (Compton, 1992, p. 8).

Figure 3.9: A view of a barn in the Buffalo River Valley, which was in danger of being submerged if the river was dammed ("Boxley Management Districts," 1985).

Though the Buffalo had been surveyed initially, it was not until the 1960s that the river was truly, seriously threatened. The Corps of Engineers began to move forward with a plan to dam the Buffalo in two locations: one at Gilbert and one at Lone Rock (Catton, 2008, p. 262). At flood stage, the proposed dams would have covered 16,000 acres of the Buffalo River valley: at low stage, only 6,200 acres (Ken Smith, 2018, p. 109). Both dams would be used for flood control and electricity, and they would have cost the US government nearly 87,000,000 dollars (Compton, 1992, p. 55). The management of the town of Marshall, situated in one of the counties where the dams would be, was wholly in favor of this idea. They believed that the dams would bring prosperity to their little Ozark town, and several people thought that the benefits of a successful town were worth the price of the Buffalo's life.

Figure 3.10: Save the Buffalo River bumper sticker created by citizens opposed to damming the river (Compton, Uark Libraries Special Collections).

Fortunately, many people disagreed. Prior to the dam threat, pro-environmentalists such as Neil Compton and Ken Smith had already been working hard to win park status for the Buffalo's Lost Valley. When the Corps of Engineers began planning to dam the river, these men and other like-minded citizens sprang into action to 'Save the Buffalo.' They generated publicity in the form of meetings, talks, photographs, and newspaper and National Geographic articles, among others, in an effort to bring awareness of the Buffalo's beauty and individuality. They advocated for the preservation of the Buffalo, meaning that it would be allowed to flow freely and flourish in its natural state with minimal human impact.

These preservationists turned their sights on the National Park Service as worthy caretakers of the Buffalo River. In 1962, they formed an official group called The Ozark Society whose purpose was to preserve nature and to fight the dams (Compton, 1992, p. 110). In the next eight years or so, The Ozark Society and the pro-dam advocates would battle it out for the fate of the Buffalo. In the beginning, congress and Arkansas' politicians were in favor of the Lone Rock and Gilbert dams. Luckily, before the Ozark Society was fully on the job, President Eisenhower had already prevented the damming of the Buffalo twice by vetoing bills that would have funded the dams, "for reasons of the economy" (Ken Smith, 2018, p. 109). The University of Arkansas' own Senator William Fulbright, too, was in favor of the dams and their promised economic change until 1961, when he changed his mind and began helping the cause to save the Buffalo. Senator Fulbright secured enough funds for the National Park Service to inspect the river and conduct a survey of what would become the proposed park boundaries. In 1963, following their investigation of the river and surrounding area, the National Park Service "recommended [the] establishment of Buffalo National River to protect the natural attributes of the Buffalo" (Ken Smith, 2018, p. 109).

Eventually, The Ozark Society succeeded in creating enough support for the river. A major win was gaining the support of many politicians, especially from the current governor of Arkansas, Governor Faubus. He stated in 1965 that

> "there is no question that both aesthetically and economically, the approval and proper construction of a National River will be far better for the area, the State of Arkansas, and the nation, than would the construction of the proposed Gilbert Dam and lake"
> (Compton, 1992, p. 245).

By 1966, the Corps of Engineers abandoned their plans for dams at Gilbert and Lone Rock, stating:

> "In view of the position of the Governor and the fact that it is the general policy of the Corps of Engineers not to recommend authorization of projects which are opposed by the States directly concerned, my previous recommendation for authorization and construction of the Gilbert Reservoir project has now been withdrawn. Accordingly, I recommend that construction of a reservoir project at the Gilbert site not be authorized by Congress. I further recommend that the Lone Rock Reservoir, authorized in the Flood Control Act approved 28 of June 1938, not be constructed."
>
> (Compton, 1992, p. 259)

The immediate threat of submersion was lifted from the Buffalo River valley, but The Ozark Society's work was not complete. Though the Corps had not succeeded in drowning the Buffalo that time, there was still no legislation in place stopping them from doing so in the future. In addition, the land surrounding the river remained private, meaning that if a large corporation chose to build an unsightly or pollution filled complex on the Buffalo, they could.

For these reasons, The Ozark Society continued to fight for National River status for the Buffalo. After a decade of struggles and years of legal negotiations, one hundred and thirty miles of the Buffalo officially became America's first National River on March 1, 1972. It was to be created "for the purposes of conserving and interpreting an area containing unique scenic and scientific features, and preserving as a free-flowing stream an important segment of the Buffalo River in Arkansas for the benefit and enjoyment of present and future generations" (Ken Smith, 2018, p. 11). Land was acquired from homeowners and legislation was codified that dictated what sort of use was allowed and appropriate for the area. With preservation in mind, park infrastructure was slowly and carefully built. And so, the ancient Buffalo River was allowed to remain wild and has become an important natural sanctuary that generations have and will continue to enjoy.

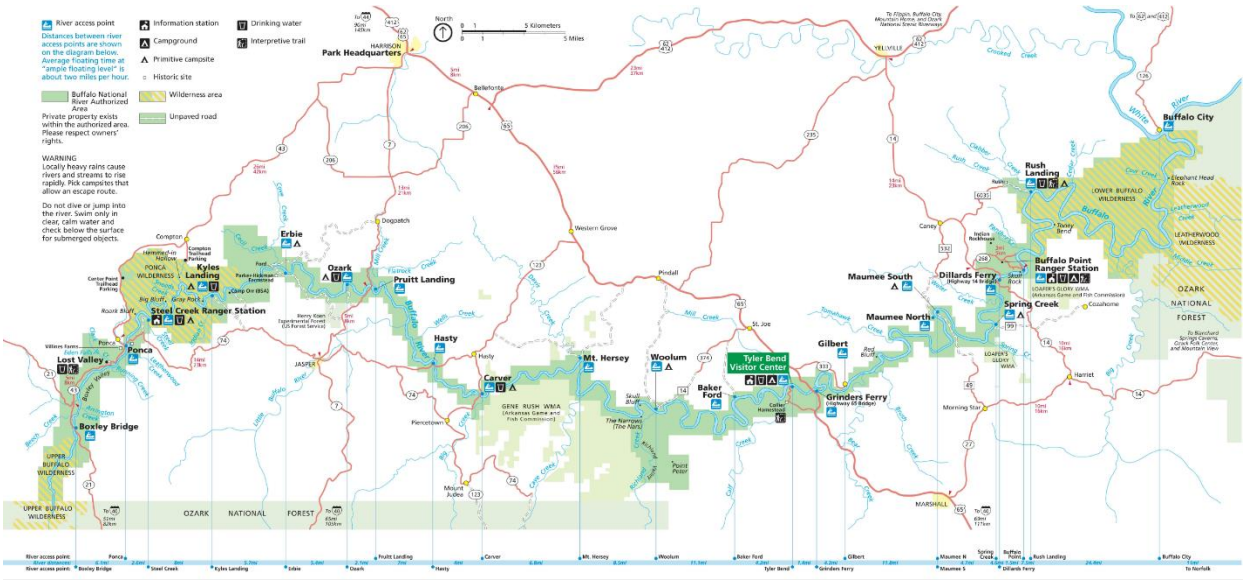


Figure 3.11: Official park service map of the current day (2019) Buffalo National River (NPS, 2019).

3-5 – Modern Day

Today, the Buffalo River is thriving under the protection of the US National Park Service. Life is abundant in the park – plants and wildlife are plentiful, as are human visitors. The Buffalo National River includes 135 miles of the river, encompasses 94,293 acres of the surrounding land, and has “135 miles of paved and unpaved road surfaces, more than 100 miles of trails, [and] 283 buildings and structures” (Ken Smith 2018, p. 122). These features are enjoyed by the average 800,000 yearly visitors to the park (“Learn About the Park,” 2019).

Though the park service is unable to count exact numbers, the most popular activities in which visitors participate are hiking and floating. Some of the other activities available include camping, backpacking, horseback riding, and swimming. Twelve boat rental outfitters serve the Buffalo; in the summertime, the cold river is a welcome reprieve from the southern heat. Water levels in the upper Buffalo can be low during the summer months, but floating is possible year-round in the middle and lower sections of the river.

Figure 3.12 : Recreationists floating on the Buffalo River ("Bird's Eye View," NPS & Fondriest).

In all seasons – perhaps excluding the heat and humidity of summer – the Buffalo National River's hiking trails offer an enjoyable trek through the woods with gorgeous scenery. The Buffalo boasts many picturesque bluffs and waterfalls, notable of which are Big Bluff and Hemmed-In-Hollow. Hemmed-In-Hollow, at 204 feet tall, is the tallest waterfall between the Appalachians and the Rockies (Ken Smith, 2018, p. 336).

America's First National River is a remarkable place with an interesting history. The Buffalo needs to be protected for posterity. As spectacular as this area is, it is still a region affording moderate to high-risk activities that can lead to loss, injury, or death. Visitors, if uninformed or underinformed, can get hurt. National Park Service rangers have three basic purposes: A) protection of visitors and park resources, B) care of the park's facilities, and C) interpretation of the park's story (Ken Smith, 2018, p. 124). A study of risk perception is

imperative to Buffalo National River park management and their ability to perform their first duty – to protect visitors and park resources – and is the thrust of this research.

Figure 3.13: A park ranger in uniform playing tug-of-war with young visitors in one of the Buffalo's many recreation areas ("Tug of War," NPS & Fondriest).

Chapter Four: Methodology

When preparing to conduct research, the investigator must thoroughly explore methods used in past studies and understand how different aspects of each can apply to their own endeavors. In the previous chapter, prior literature pertaining to risk perception was discussed. This chapter will delve deeper into the strategies used by these preceding researchers and then discuss how they are relevant in the context of this thesis. Methodological choices such as utilizing questionnaires, the Likert scale, ranking, and mapping sections have all proven to be effective tools in data gathering and analysis. Each proven method was employed in this thesis, creating a replicable research strategy.

4-1 – Prior Use and Creation of Questionnaire

Questionnaires are widely used among a variety of disciplines as a tool for gathering data. More importantly, questionnaires are a suitable method of data collection for many geographic and risk perception studies. Generally, “the objective of a questionnaire is to gather factual data from the respondent when no other source for obtaining the required information is available” (Haring & Lounsbury, 1992, p. 46) This definition of a questionnaire’s objective holds true with risk perception research; a person’s responses on a questionnaire are both factual and unique. Perception varies from person to person, so participants’ responses are facts as they see it. Each individual is the only person who can effectively communicate their own perception, so the only source from which to gather risk perception data is the participant themselves.

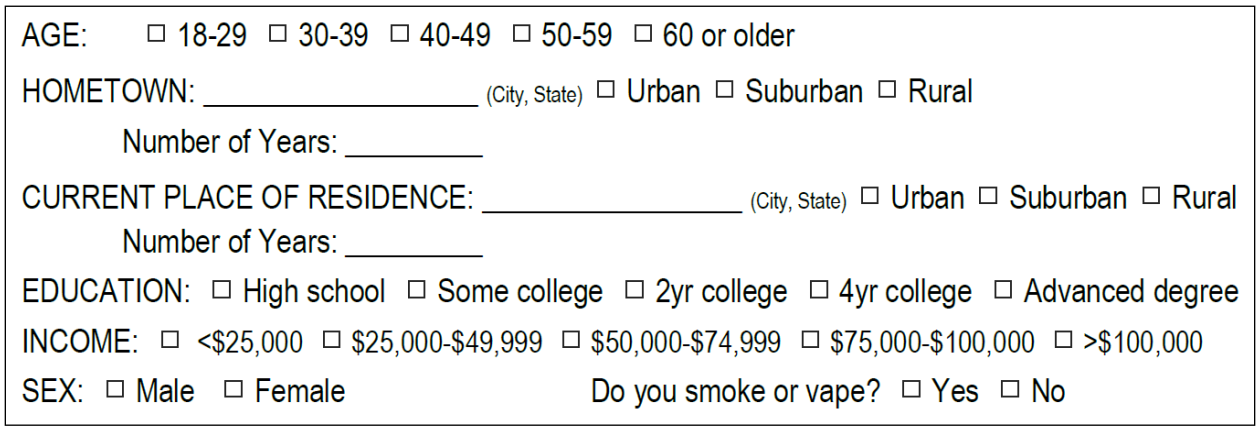
Utilizing a survey or questionnaire to collect data for risk perception studies is a technique that goes back to Slovic, Fischhoff, and Lichtenstein. In one of their early articles “Why Study Risk Perception?,” the trio described giving participants a survey filled with questions that used the psychometric scaling technique (Slovic, Fischhoff, & Lichtenstein, 1982). Since then, questionnaires have been a popular data gathering technique within the field

of risk perception. D. Bird, in their article on the use of questionnaires in perception research, states that

> "questionnaires can be used to reveal information on public knowledge, attitude, perception, experience and preparedness levels in relation to natural hazards. When this information is combined through a mixed methods approach, robust results can be obtained, which are both comprehensive and quantifiable, adding an invaluable perspective to the development of appropriate risk mitigation and adaptation strategies."
>
> (Bird, 2009, p. 1322)

For these reasons, a questionnaire was used to gather data for this research.

The questionnaire created for this thesis was generally modeled after work by Ahrens (2014) and Paradise (2005). It is one-page front-and-back in length and contains 24 questions. The first section, as with Ahrens and Paradise, contains demographic questions designed to gather information on age, education, income, and sex. Included in this section also are questions on hometown and current place of residence, and whether or not the participant smokes of vapes. The first two questions are to establish a spatial point of reference, and the question on smoking is included to assess whether or not the participant exhibits risky behavior.


AGE: ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 or older

HOMETOWN: _____ (City, State) ☐ Urban ☐ Suburban ☐ Rural

Number of Years: _____

CURRENT PLACE OF RESIDENCE: _____ (City, State) ☐ Urban ☐ Suburban ☐ Rural

Number of Years: _____

EDUCATION: ☐ High school ☐ Some college ☐ 2yr college ☐ 4yr college ☐ Advanced degree

INCOME: ☐ <$25,000 ☐ $25,000-$49,999 ☐ $50,000-$74,999 ☐ $75,000-$100,000 ☐ >$100,000

SEX: ☐ Male ☐ Female Do you smoke or vape? ☐ Yes ☐ No

Figure 4.1: A clipping from Section 1 of the questionnaire used in this thesis.

Following the demographics section is a section assessing the participants' experience with the Buffalo National River. Questions asking how many years they have been visiting the

BNR, what activities they participate in, and what their reported skill level is are included. Later in the same section, questions are asked which require the participant to respond by marking 'strongly disagree,' 'disagree,' 'neutral,' 'agree,' or 'strongly agree.' This is the Likert scale, a method also employed by Ahrens and Paradise (2014; 2005).

How many times per year do you visit the Buffalo National River (BNR)? _____

Approximately how many years have you been visiting the BNR? _____

What activity/activities do you participate in?

☐ Kayaking/Canoeing ☐ Tubing ☐ Swimming ☐ Day hiking ☐ Overnight hiking

☐ Car camping ☐ Recreation area use ☐ Horseback riding ☐ _____

How many years have you done said activity/activities? _____

I would say that my skill level is… ☐ Beginner ☐ Intermediate ☐ Expert

Statement…	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
I always research before doing one of the activities listed.					
I always wear my life jacket in/on the river.					
I always follow warning signs.					
The information presented by the National Park Service is useful.					
I have a plan in case of injury.					
I have a plan for personal evacuation.					
I am concerned about cell phone service.					
I am aware of safety resources available to me.					

Please list all safety resources that you are aware of:

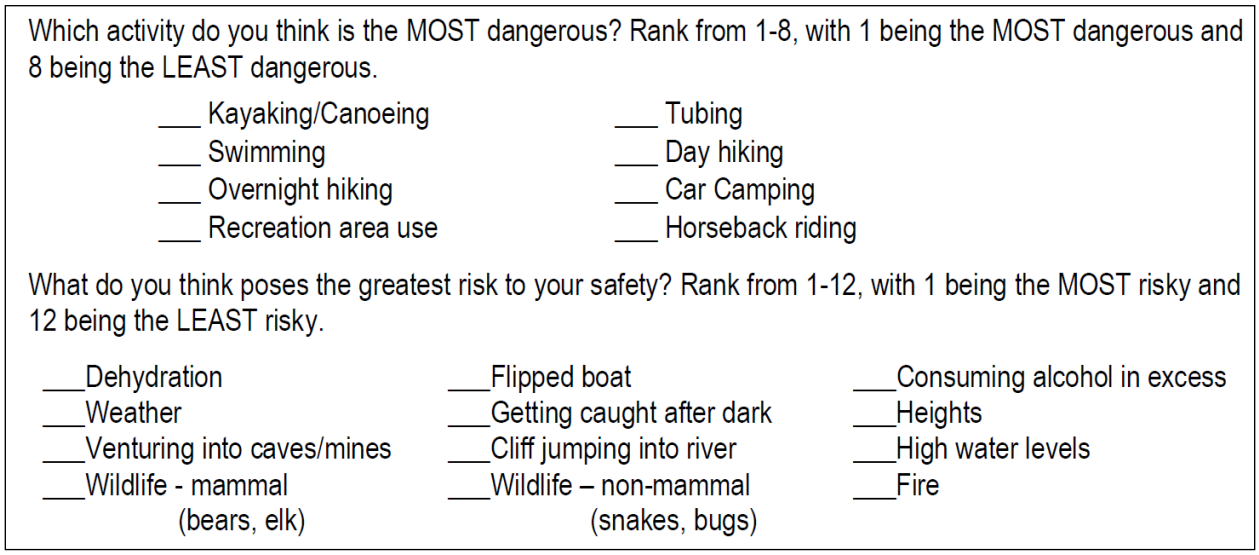
_____

_____

Figure 4.2: A clipping from Section 2 of the questionnaire used in this thesis.

On the backside of the page, participants were asked to rank activities and hazards in order from least dangerous/risky to most dangerous/risky. Ahrens' questionnaire included a similar question, asking "Who are the most dangerous boat drivers on Beaver Lake? Rank from 1-8 (1 = most dangerous, 8 = least dangerous)" (Ahrens, 2014). These ordinal data responses

allowed Ahrens an insight into perceptions participants had on the age range of boaters involved in accidents.



Which activity do you think is the MOST dangerous? Rank from 1-8, with 1 being the MOST dangerous and 8 being the LEAST dangerous.

___ Kayaking/Canoeing
___ Swimming
___ Overnight hiking
___ Recreation area use
___ Tubing
___ Day hiking
___ Car Camping
___ Horseback riding

What do you think poses the greatest risk to your safety? Rank from 1-12, with 1 being the MOST risky and 12 being the LEAST risky.

___Dehydration
___Weather
___Venturing into caves/mines
___Wildlife - mammal (bears, elk)
___Flipped boat
___Getting caught after dark
___Cliff jumping into river
___Wildlife – non-mammal (snakes, bugs)
___Consuming alcohol in excess
___Heights
___High water levels
___Fire

Figure 4.3: A clipping from Section 3 of the questionnaire used in this thesis.

Lastly, participants were asked to mark an 'X' on the map to indicate the areas they believed to be risky. To avoid the issue of too many responses, the question included specific instructions to mark no more than 5 points on the map. Ahrens (2014) also incorporated a similar map in her study. She then used the responses to generate graduated circle maps indicating the number of times an area was selected as being risky in conjunction with the demographics of those making the selection.

After the Likert scale questions in Section 2 is an opportunity for participants to list all safety resources that they are aware of. There was also a 'comments' section at the end of the questionnaire. These opportunities for qualitative or anecdotal remarks "can be used to corroborate, illustrate, or elaborate on the meaning of quantitative responses" (Bird, 2009). These open-ended questions are just as important as closed questions in order to understand a participant's perception.

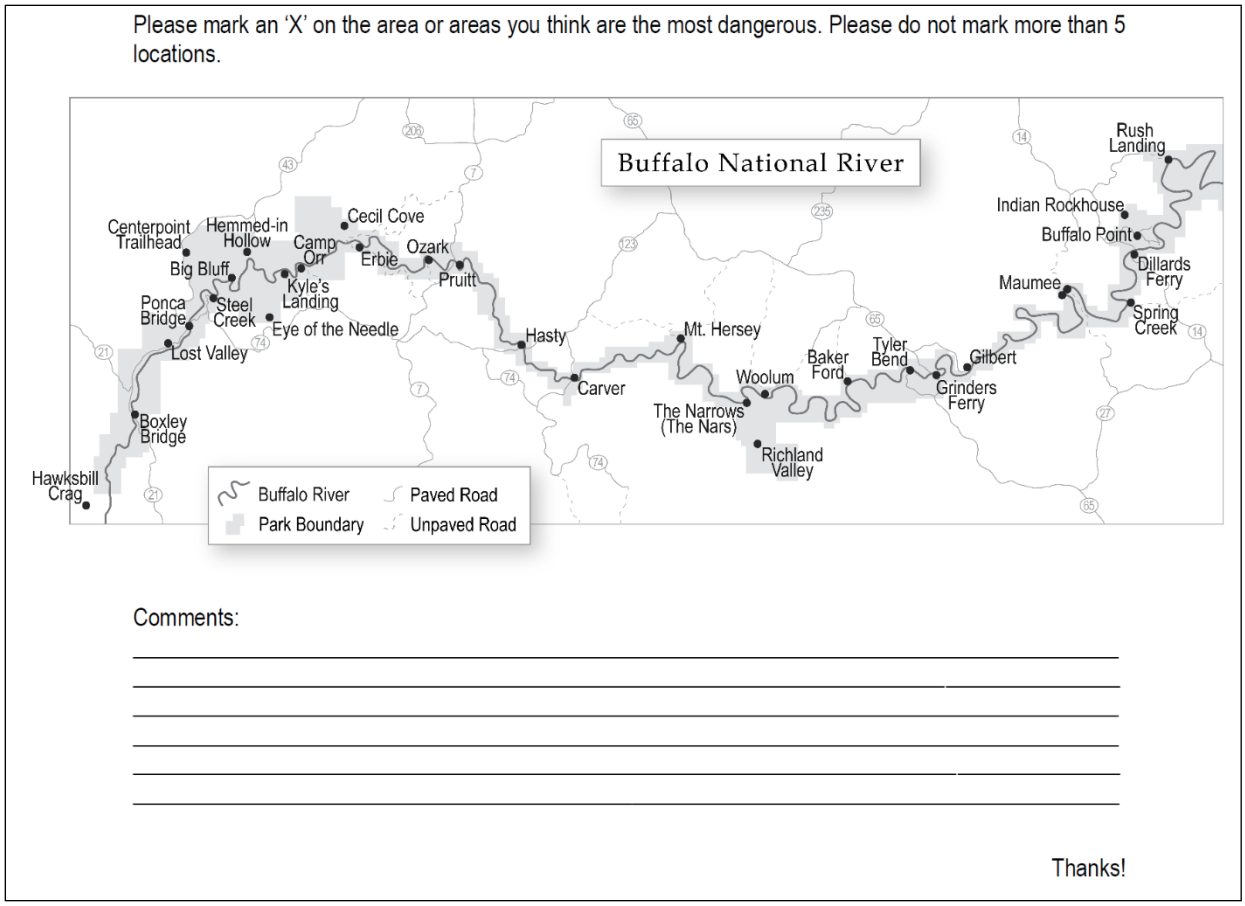


Figure 4.4: A clipping from Section 4 of the questionnaire used in this thesis.

4-2 - Survey Procedure

Once the survey instrument was created and the proper approvals from both the National Park Service (NPS) and the University of Arkansas were obtained, data collection began. Surveys were administered on three days at four different locations within or near the Buffalo National River between February and April of 2019. A total of 80 surveys were completed, and because of time and financial constraints, no further surveys were obtained. Surveys were conducted face-to-face and participants were targeted spatially (Bird, 2009). Any visitors to the BNR who were near the survey administer were asked to participate, though it is likely that some visitors passed by without interaction while other visitors were being surveyed. Potential participants were made aware that partaking in the survey was voluntary and all

responses were anonymous both verbally and on a small sheet of paper that was given to each participant.

4-3 – Collection of Search and Rescue Records

Records of past search and rescue (SAR) events in the Buffalo National River were collected in order to gather data that could be compared to the results of the survey. Travis Heggie (2009) has frequently used the National Park Service's annual SAR reports in his research. His two 2009 articles, as well as his 2008 article, use the reported annual SAR statistics to compute trends in spatiality. Initially, these annual SAR reports were targeted for this study, but the data available for the Buffalo National River does not break the incident down by location. Heggie succeeded in using the annual SAR reports to compare between parks, but comparison within a park was more difficult. For these reasons, more in-depth SAR data was sought out.

Working in conjunction with the patient and knowledgeable dispatch workers at the Buffalo National River headquarters in Harrison, Arkansas, data on each individual SAR event from 2011-2017 was recorded. The NPS does not have a specific database where SAR data is stored or even a template for how to record it. Instead, data including the date, time, and location of the SAR, age and gender of the victim, and other variables were contained in the form of reports written by the people responding to the SAR. With the help of Mr. Louie Stoops, the head dispatcher of the BNR area, this data was recorded into an excel sheet and was then cleaned and later analyzed with the questionnaire data.

4-4 – Strategies for Analysis

After survey administration was finished, the completed surveys were office-coded with an ID number (Bird, 2009). In addition, each section on the survey was given a letter and each question was given a code (for example: Section C, Question 4), to enable easier data analysis.

Questionnaire data were then entered into a Microsoft Excel sheet. The R programming language within RStudio was used to assess descriptive statistics of the questionnaire data, and further analysis was done using pivot tables in Microsoft Excel. Graphs were created using R to visually represent the data from each survey question, and maps were created in Illustrator using information resulting from the pivot tables. For Section F of the questionnaire, marked areas of perceived risk were spatially referenced using Google Earth and Esri's ArcGIS.

The search and rescue data collected from the NPS were entered into a Microsoft Excel File. Much of the information included in the National Park Service's reports was anecdotal, so the collected data were tidied up before use to make them more compatible with R. Some columns of SAR data remained unusable. If no coordinates were included in the NPS data reports, coordinates were found using Google Earth and Esri's ArcGIS based on the recorded anecdotal location (such as "Lost Valley"). Following cleaning, the data were loaded into R and descriptive statistics were found. Graphs were made in R for columns of data using this information, where possible. Excel's pivot tables were used to compare sections of data, and maps were created in Illustrator using this information.

Geospatial data is incredibly useful because it contains two parts – the spatial component and the other data that is tied to the location. This means that geospatial data can give researchers a deeper understanding of what is going on in the dataset. The resulting maps of both data categories – surveyed perception data and gathered SAR data – were then visually compared. Geospatial trends were assessed between the two, locating knowledge gaps between where visitors perceive risk to be and where search and rescue events actually occur.

Chapter Five: Results and Discussion

Recording demographic data on participants is an integral part of any survey as it can be used to “characterize and correlate a population” (Ahrens, 2014). The demographic data gathered for this study will be compared to other search and rescue data to determine if a piece of information is a possible explanation for a knowledge gap. Alternatively, demographic data could be a key factor as to why a population is well prepared for activities in a National Park.

Figure 5.1: Sign found on the side of the road leaving the Steel Creek river access point in the Buffalo National River (Personal photo).

Though the Buffalo National River records total number of recreational visitors per month, they do not record any demographic data. Therefore, it is impossible to determine if this sample of demographics accurately reflects that of the visitor population to the Buffalo. Instead of comparing the following data to demographic statistics recorded by the National Park Service

(NPS), these data will be compared with the search and rescue (SAR) data recorded by the Buffalo National River (BNR). This study aims to analyze the data in an attempt to find any gaps in visitors' knowledge of hazards and risk in the Buffalo National River.

5-1 – Descriptive Statistics, Questionnaire Section A

Age Range (Question A1)

On the questionnaire, participants had the option to select one of five age-range choices: 18-29, 30-39, 40-49, 50-59, or 60+. Out of the eighty survey participants, slightly over half (51%) fell into the 18-29 category. 14% of respondents fell into the 50-59 age category, 30-39 and 60+ categories represented 13% each, and only 10% of participants surveyed fell into the 40-49 category.

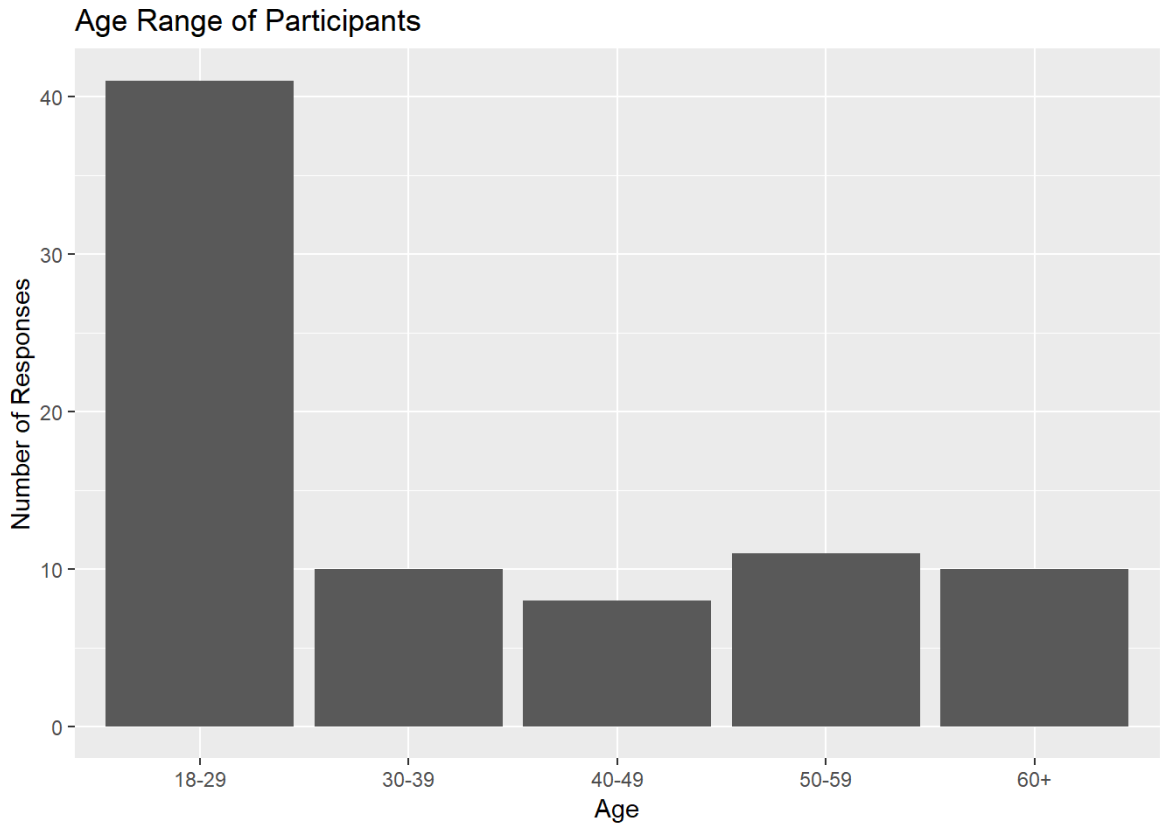


Figure 5.2: Graph representing ages of survey participants. Created in RStudio.

Sex of Participants (Question A10)

Question A10 on the survey asked participants to record their sex. 61% of respondents recorded their sex as male, while just 39% of respondents identified as female.

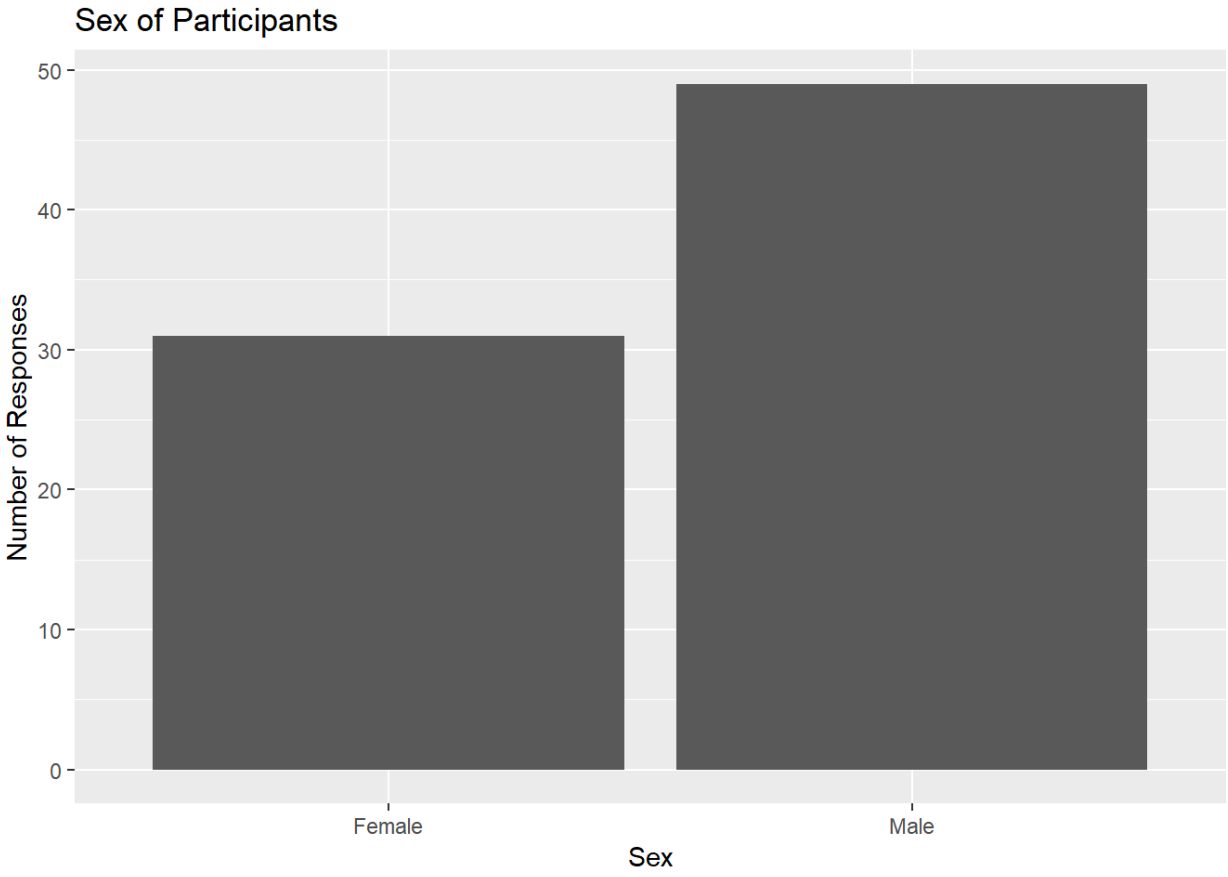


Figure 5.3: Graph depicting the number of females and males that participated in the survey. Created in RStudio.

Participants' Highest Level of Education (Question A8)

Participants were asked to record their highest level of education on the questionnaire. The choices ranged from 'High School' to 'Advanced Degree.' One person declined to respond to the question. Of the rest, 14% had completed high school and 19% had at least some college. 9% of respondents recorded having completed a 2-year degree, 34% a 4-year degree, and 24% indicated that they had completed an advanced degree.

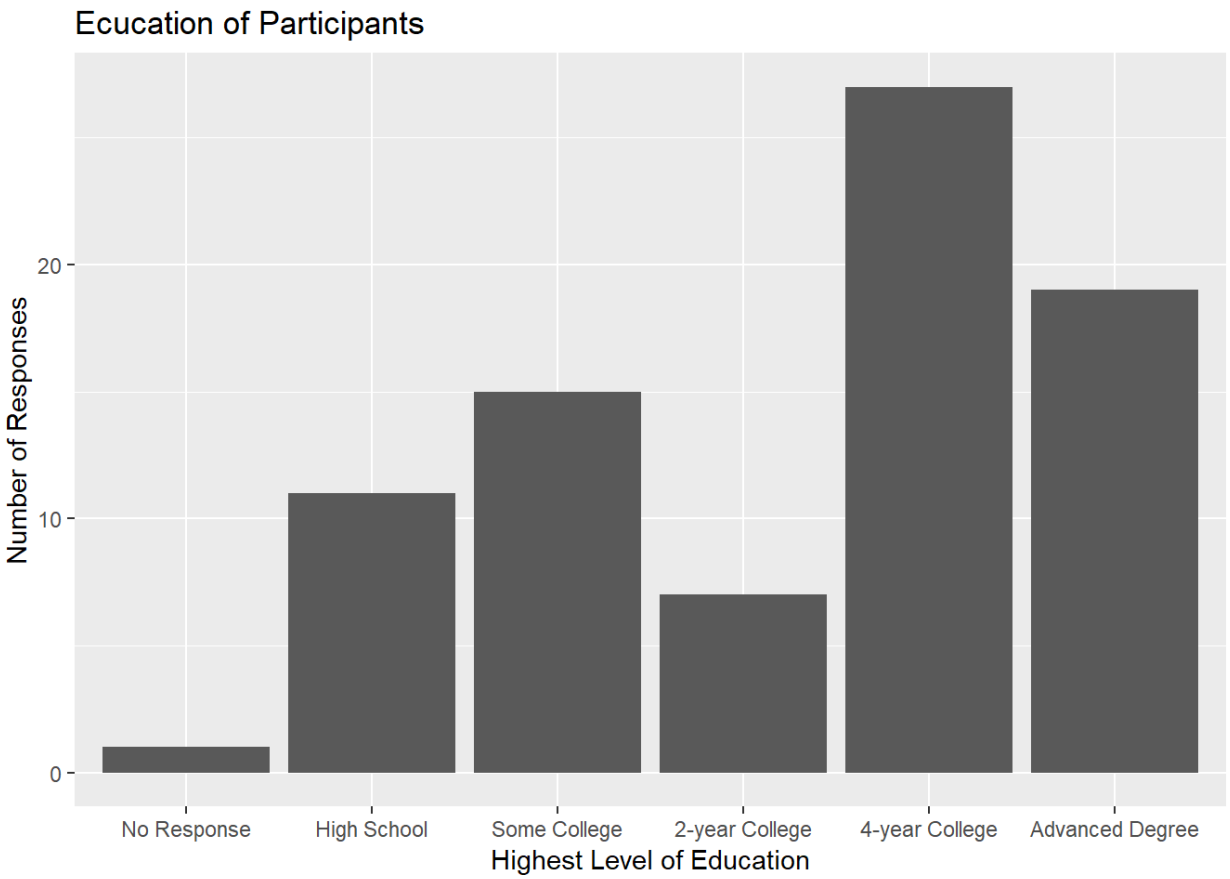


Figure 5.4: Graph representing the highest level of education obtained by survey participants. Created in RStudio.

Income (Question A9)

Of the 80 survey participants, 6 people (8%) declined to respond to question A9, asking their income bracket. 28% of participants had an income of less than $25,000 per year, and another 24% reported making $25,000 - $49,999 per year. 19% of respondents said they a yearly income between $50,000 - $74,999, 13% between $75,000 - $100,000, and another 10% of respondents fell into the income bracket making greater than $100,000 per year.

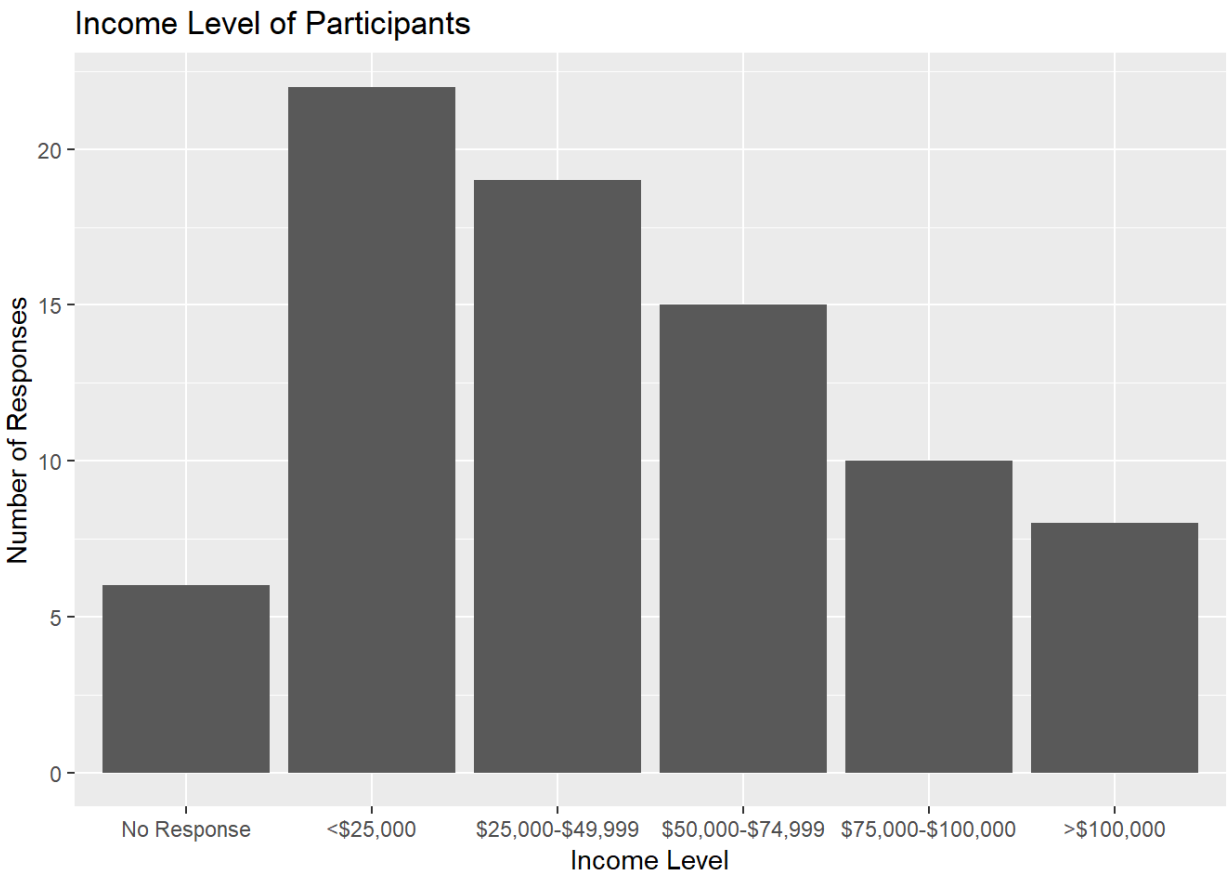


Figure 5.5: Graph representing the number of participants in each income bracket. Created in RStudio.

Hometown (Question A2)

Because this is a geographic study, participants were asked to record their hometown and current city. Participants wrote the name of their hometown and the state that it is in on question A2. As expected for such an open-ended question, the responses were widely varied. A graph was made depicting the number of participants from each recorded state, since a graph of the 43 recorded hometowns would not be easily read. The home state graph tells us that 63% of participants are native Arkansans. The next largest number of people (20%) said they were from Missouri, while only 5% of participants were from Texas. 3% were from Tennessee and Illinois, and California, Colorado, Oklahoma, South Carolina, and Wyoming each represented

only 1% of survey respondents. In addition to all these American states, one survey participant responded that their hometown was Oxford, in the United Kingdom.

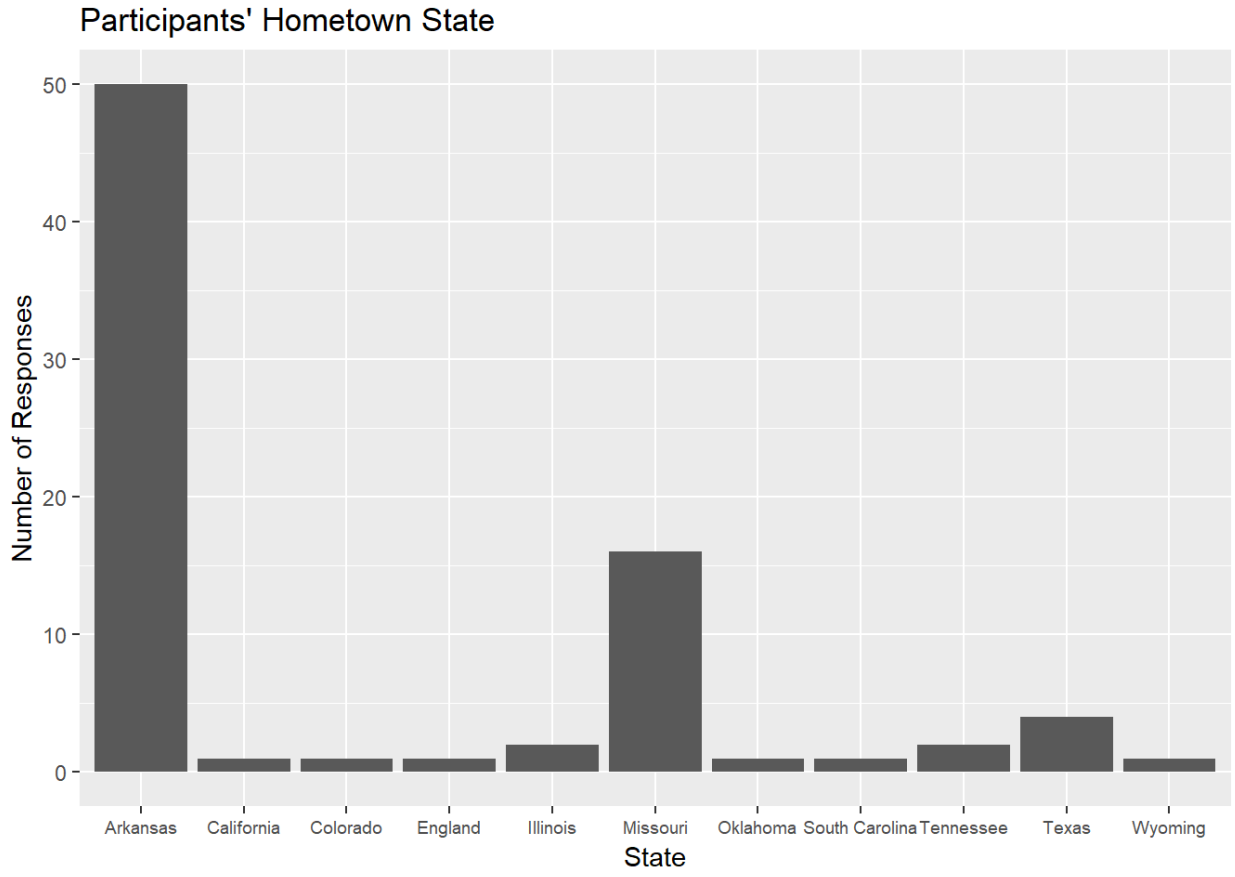


Figure 5.6: Graph depicting the number of participants who call each state their hometown state. Created in R Studio.

Instead of a graph, the recorded hometowns were compiled into a map showing the spatial distribution of participants' recorded hometown. The map shows us that the majority of hometowns are in Arkansas or Southern Missouri. There appears to be a cluster of hometowns in a fairly large circle surrounding the Buffalo National River. Fayetteville, AR represents the hometown with the largest number of participants – 6 people, or 8%. Springfield, MO is next with 5 participants (6%). Four towns were the hometown of three participants, and ten other

towns were the hometown of two participants. The remaining 37 recorded towns were the hometown of only one participant each.

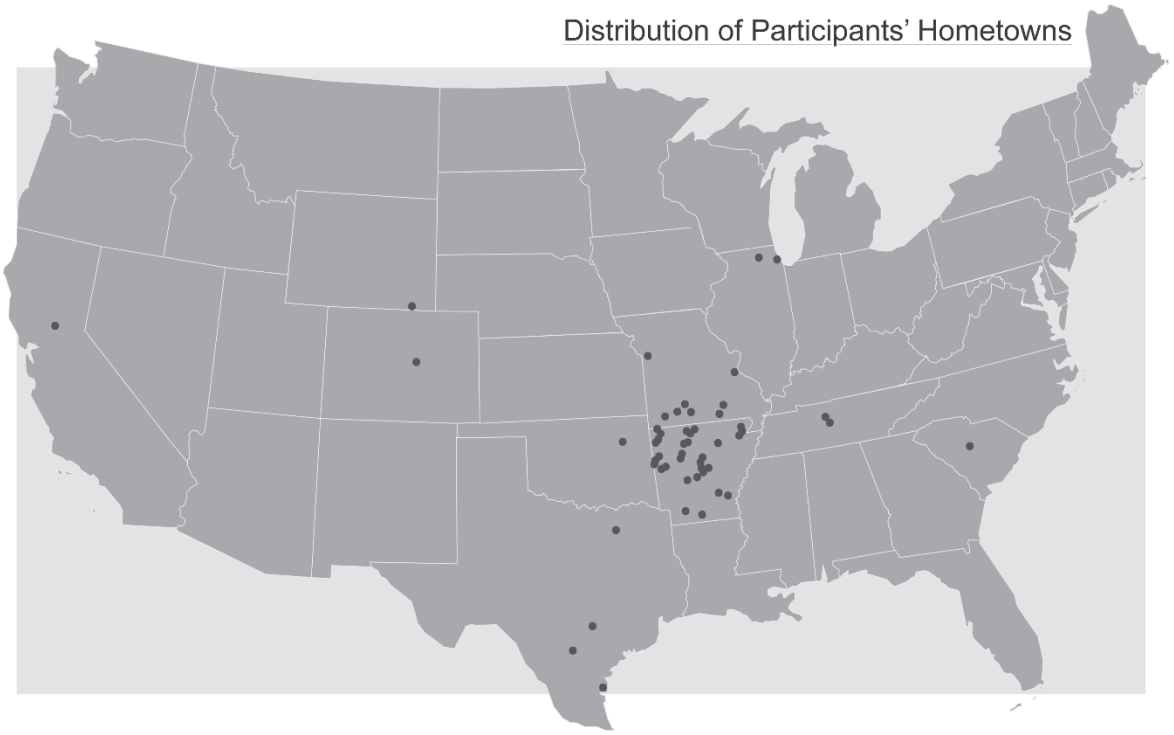


Figure 5.7: Map showing the geographic distribution of 79 participants' hometowns. One hometown, Oxford, England, was not mapped because of the geographic extent possible in this format (Terhune 2019).

Is your hometown urban, suburban, or rural? (Question A3)

In question A3, participants were asked to categorize their hometown as urban, suburban, or rural. 23% said their hometown was urban, 33% classified their hometown as a suburban place, and 45% of participants said they hailed from a rural area.

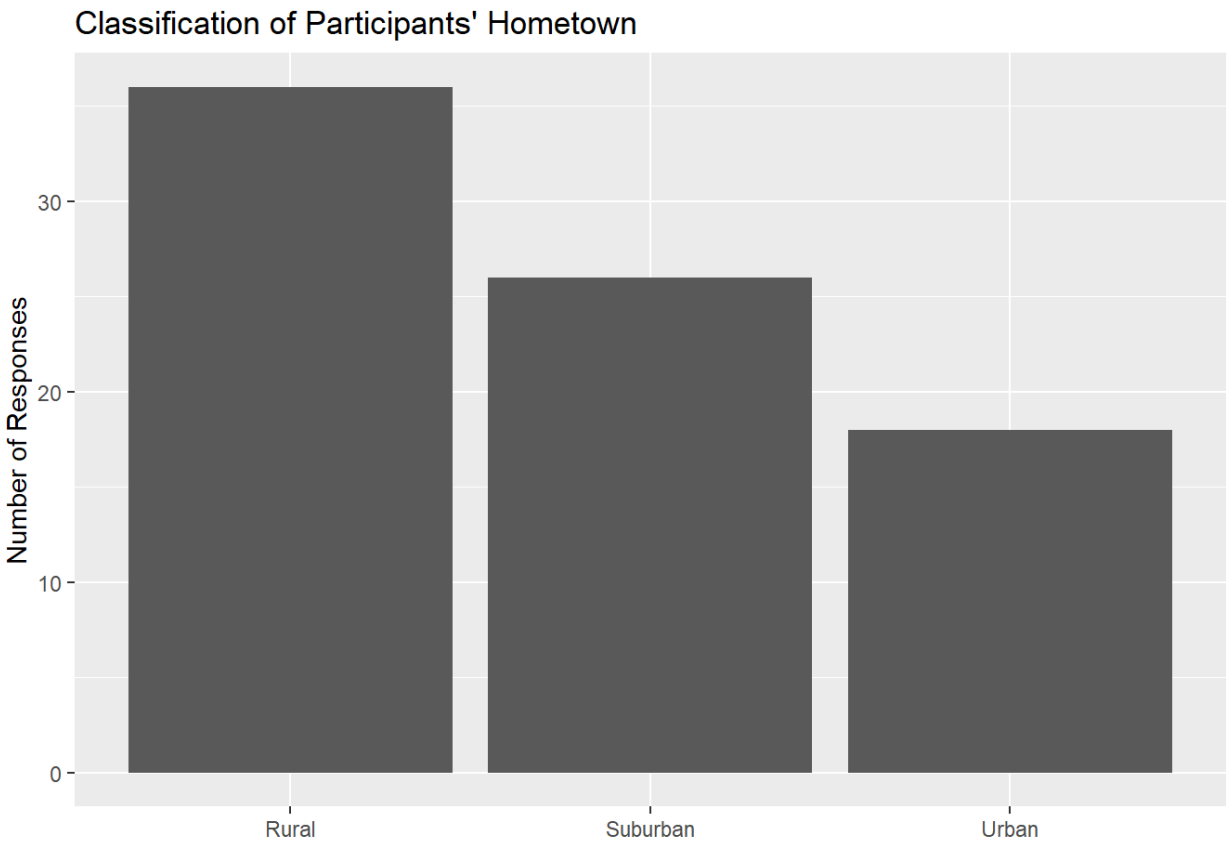


Figure 5.8: Graph representing the number of people who reported their hometown as rural, suburban, or urban. Created in RStudio.

Number of Years in Hometown (Question A4)

Participants were also asked to record the number of years they spent in their hometown. This was an open-ended question, and participants responded with a wide range of answers. Participants said that they lived in their hometown for anywhere from 1 to 58 years. Four people declined to respond to this question. The largest group of people – representing 15% of the total responses – said they spent 18 years in their hometown.

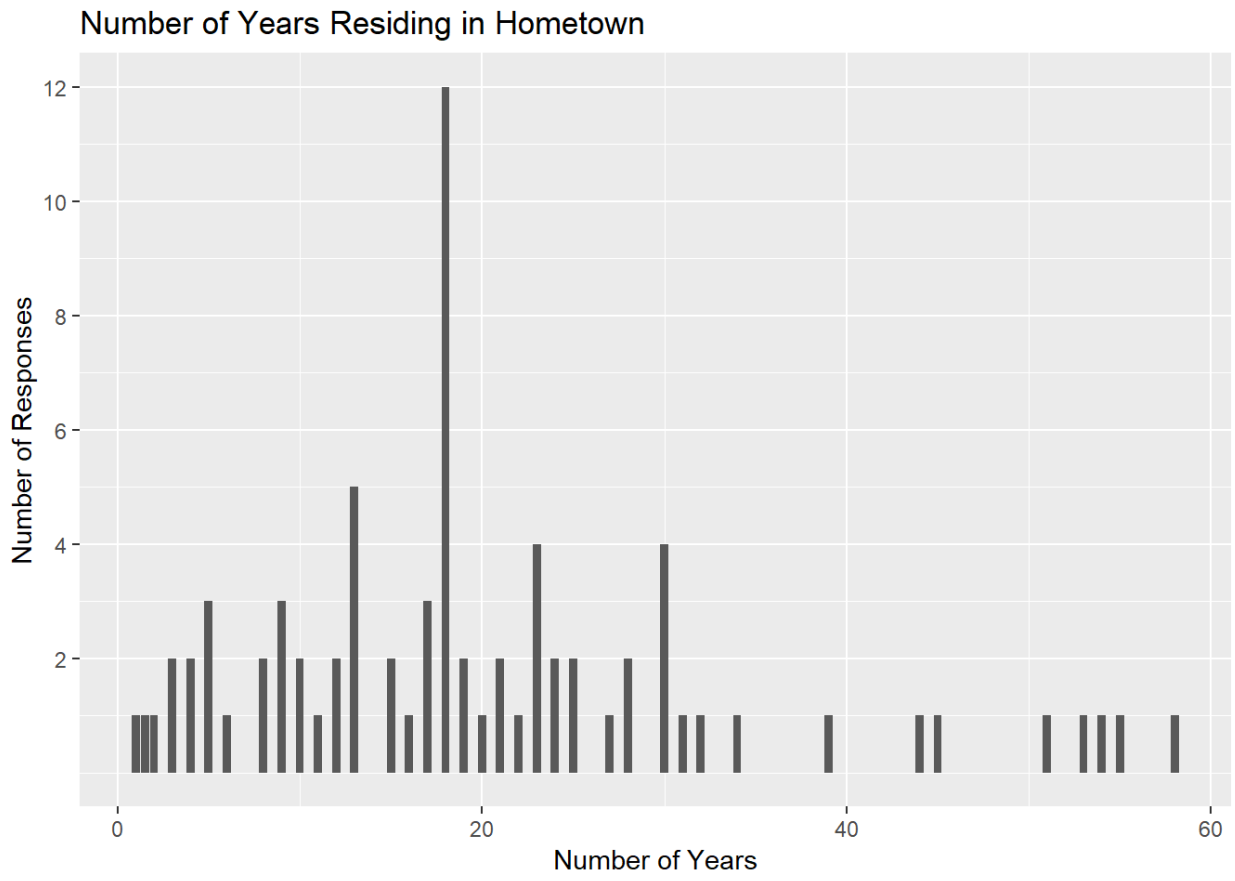


Figure 5.9: Graph representing the number of years participants lived in their hometowns. Created in RStudio.

Participant's Current Place of Residence (Question A5)

Question A5 asked the survey participants to record their current city and state. Like the hometown question (A2), responses varied greatly and a graph representing current state was created rather than one representing current city. Participants currently live in only five states, as opposed to having eleven different hometown states. Arkansas still represented the majority of participants at 70% of the total surveyed. Missouri, again, fell in second place with 20%. Texas, Illinois, and Oklahoma represented the remaining 5%, 4%, and 1%, respectively.

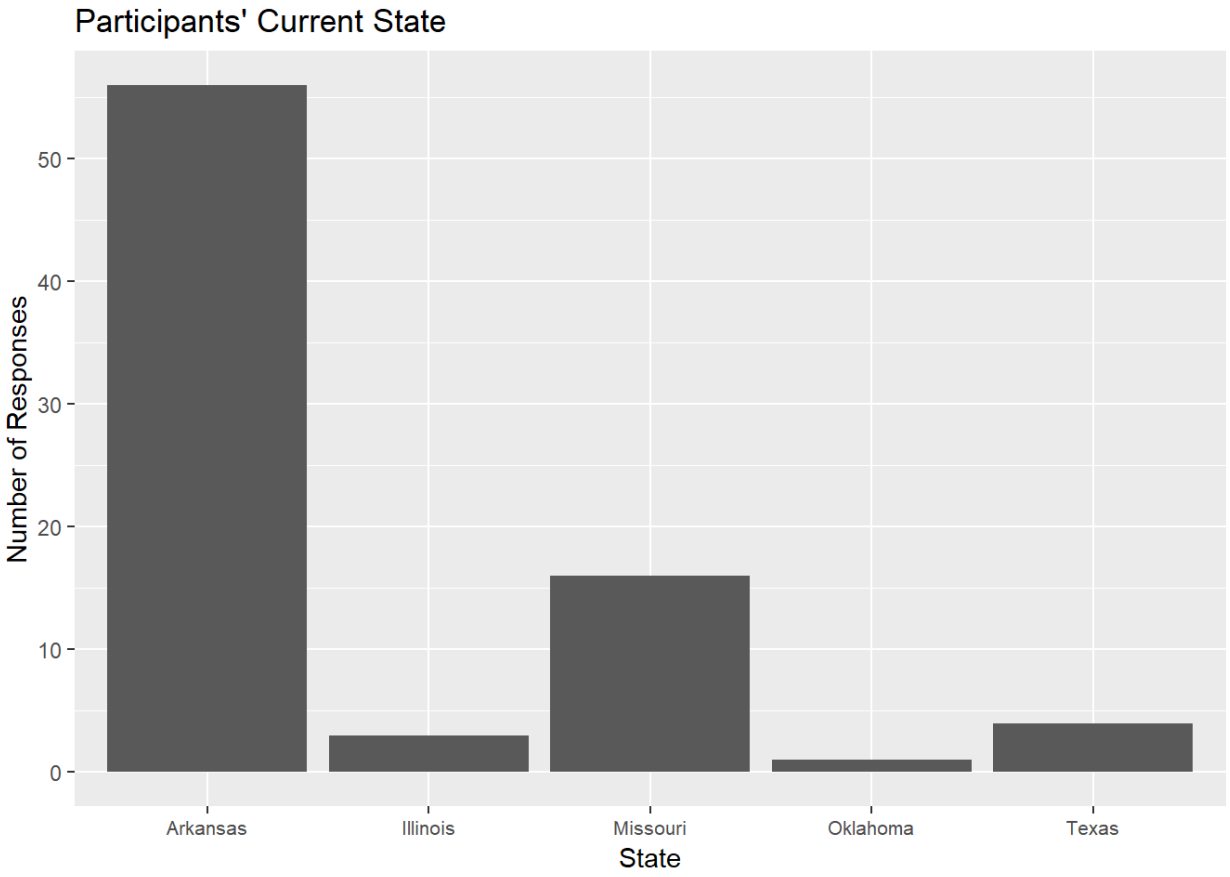


Figure 5.10: Graph representing how many participants currently live in each state listed. Created using RStudio.

When mapped, it is evident that the visitors surveyed are currently living in cities closer to the Buffalo National River than those that they call their hometowns. The current places of residence are situated largely in Arkansas, Southern Missouri, or Eastern Oklahoma, with only four data points outside that area. Fayetteville, Arkansas still represented the largest proportion of survey participants, since 26% of participants recorded it as their current city. Springfield, Missouri and Mountain View, Arkansas represented 8% and 5% of participants respectively, and Russellville, Jonesboro, Harrison, and El Dorado, Arkansas represented 3% each.

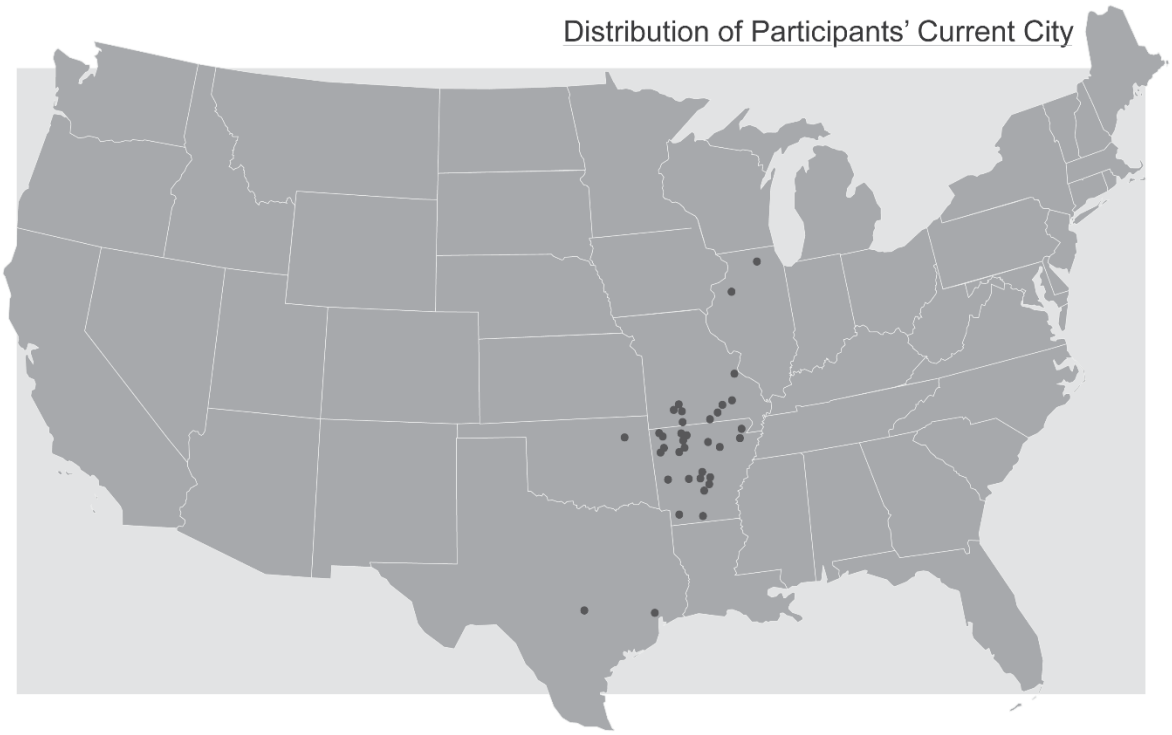


Figure 5.11: Map depicting the spatial distribution of participants' current place of residence (Terhune 2019).

Is your current place of residence urban, suburban, or rural? (Question A6)

Participants were again asked to classify their city as urban, suburban, or rural, this time for their current place of residence. 39% of participants said their current place of residence was rural, 29% selected 'suburban,' and 33% said they currently lived in an urban area.

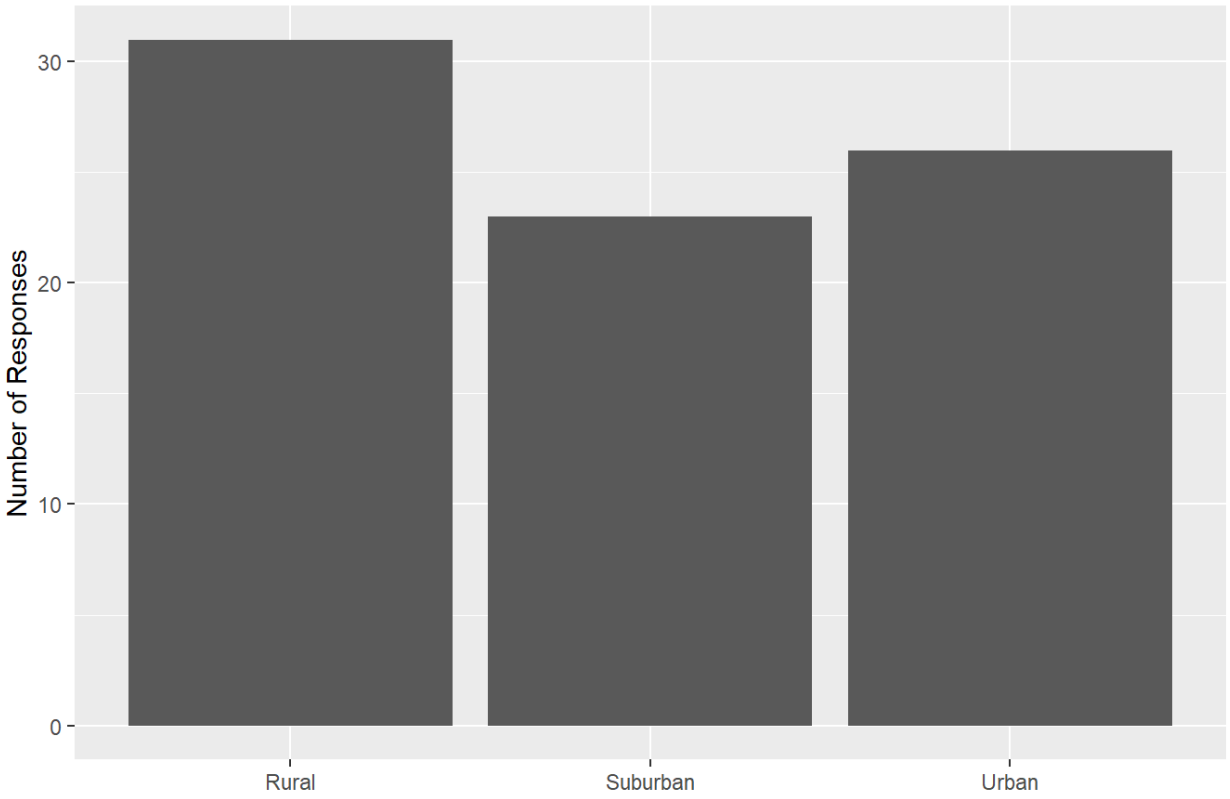


Figure 5.12: Graph representing the number of participants who labeled their current place of residence as rural, suburban, or urban. Created in RStudio.

Number of years in current place of residence (Question A7)

Participants were also asked to record the number of years they have lived in their current place of residence. This distribution of answers is skewed more to the right than question A4, the number of years participants resided in their hometown. This time, answers to this open-ended question ranged from just half of a year all the way up to 58 years. The largest amount of participants (15% of the total) have been in their current city for 5 years.

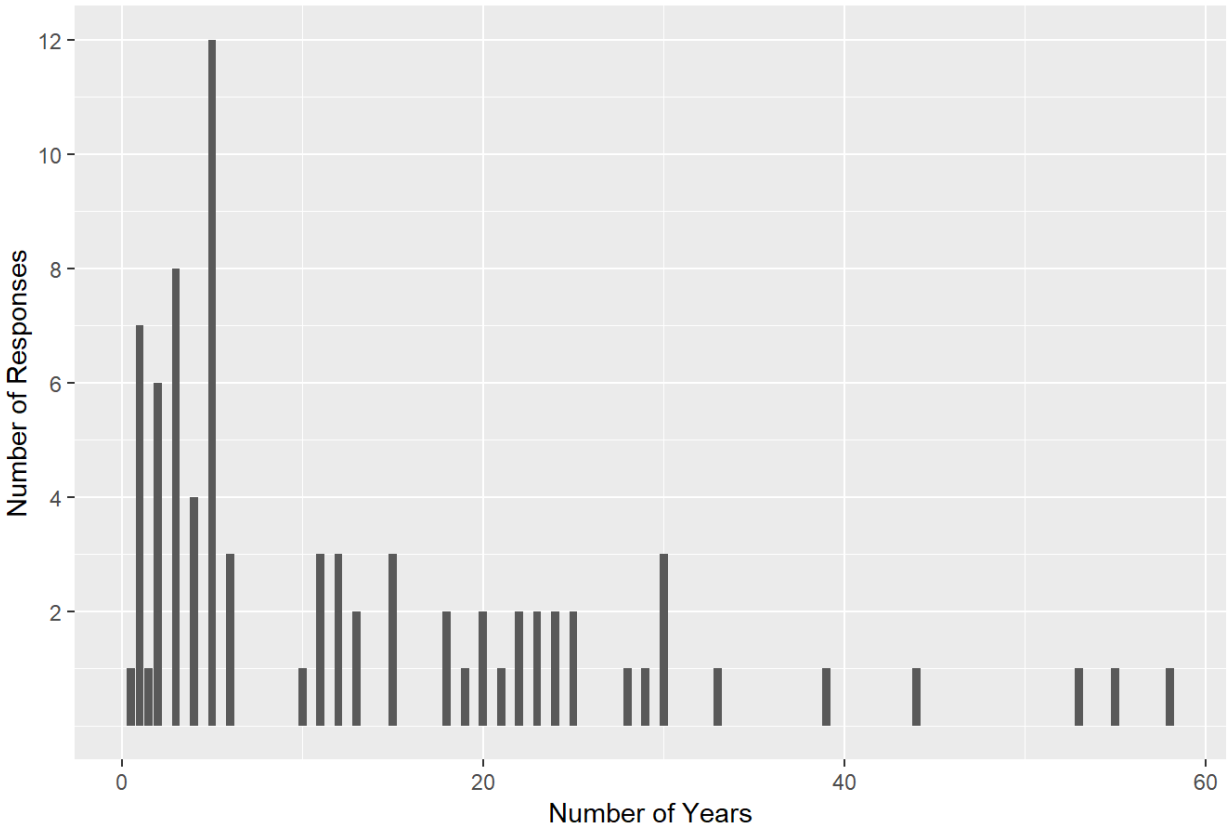


Figure 5.13: Graph representing the number of people residing in their current city for a given amount of years. Created in RStudio.

Do you smoke or vape? (Question A11)

In addition to the previous demographic and geographic questions, survey participants were also asked if they smoke or vape. This question has been used historically as an indicator of risky behavior. In theory, if a person smokes (or, more recently, vapes) then they will be more likely to accept risk and perform or engage in risky activities. In this sampling, only 10% of respondents admitted to smoking and/or vaping. 86% said no, they do not smoke or vape, and 4% declined to respond.

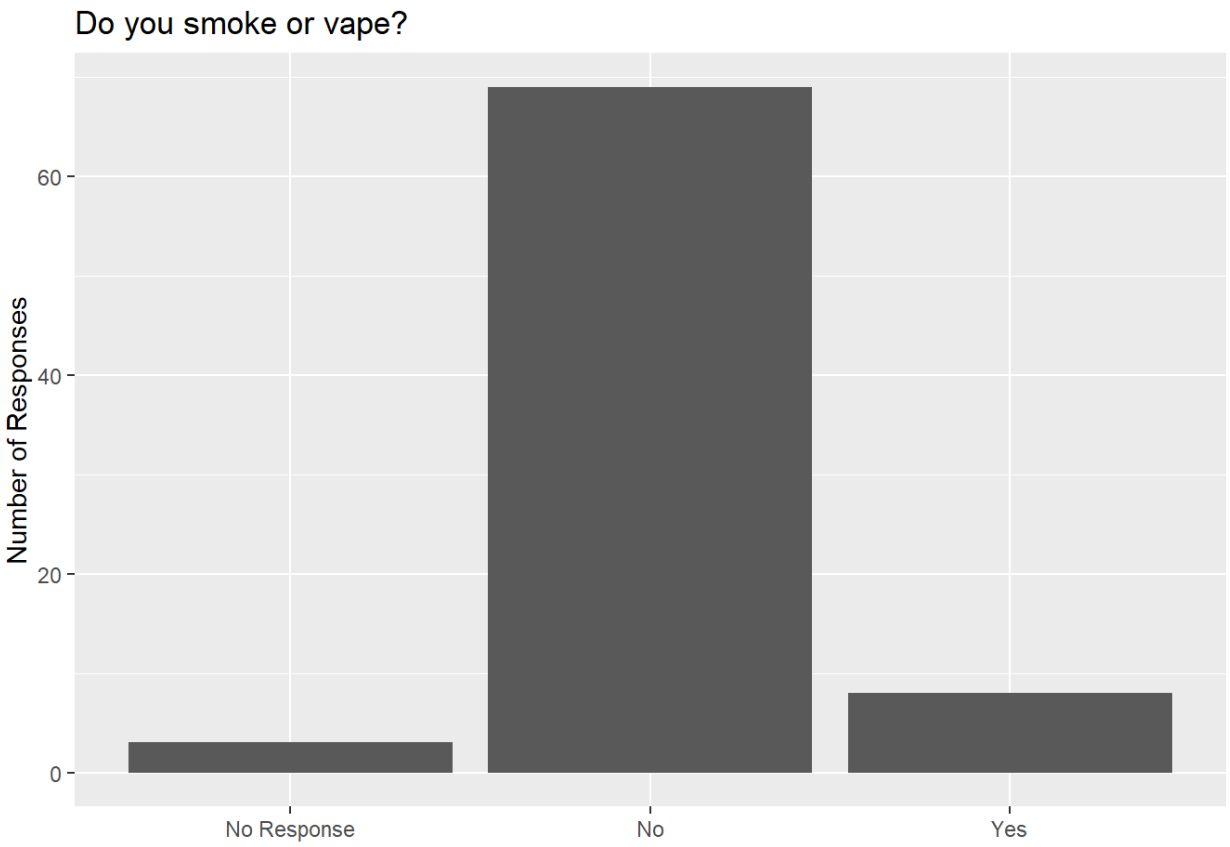


Figure 5.14: Graph representing if survey participants smoke or vape. Created in RStudio.

5-2 – Descriptive Statistics, Questionnaire Section B

Approximately how many times per year do you visit the Buffalo National River? (Question B1)

The next section, Section B, asked participants questions pertaining to their experience in the Buffalo National River and with outdoor activities in general. Question B1 asked participants to record approximately how many times per year that they visited the Buffalo River. This question was open-ended, and participants could write down whatever number they wished. Responses varied from zero times per year to 365 times per year. Very few of the data points were exactly the same, so these open-ended responses were categorized into groups to

more clearly depict the dataset. Participants responses were broken six possible groups: No Response, 0, 1-5, 6-10, 11-15, and 20 or more. Only 1% of the surveyed population declined to reply, leaving no response. 9% of people said that they visited the Buffalo zero times per year, meaning that day that they were surveyed was their first visit to the river. The largest group, 51%, said that they visited the Buffalo approximately 1-5 times per year. 14% said they visited between 6 and 10 times per year, 9% between 11 and 15 times per year, and 16% of those surveyed said they visited 20 or more times per year.

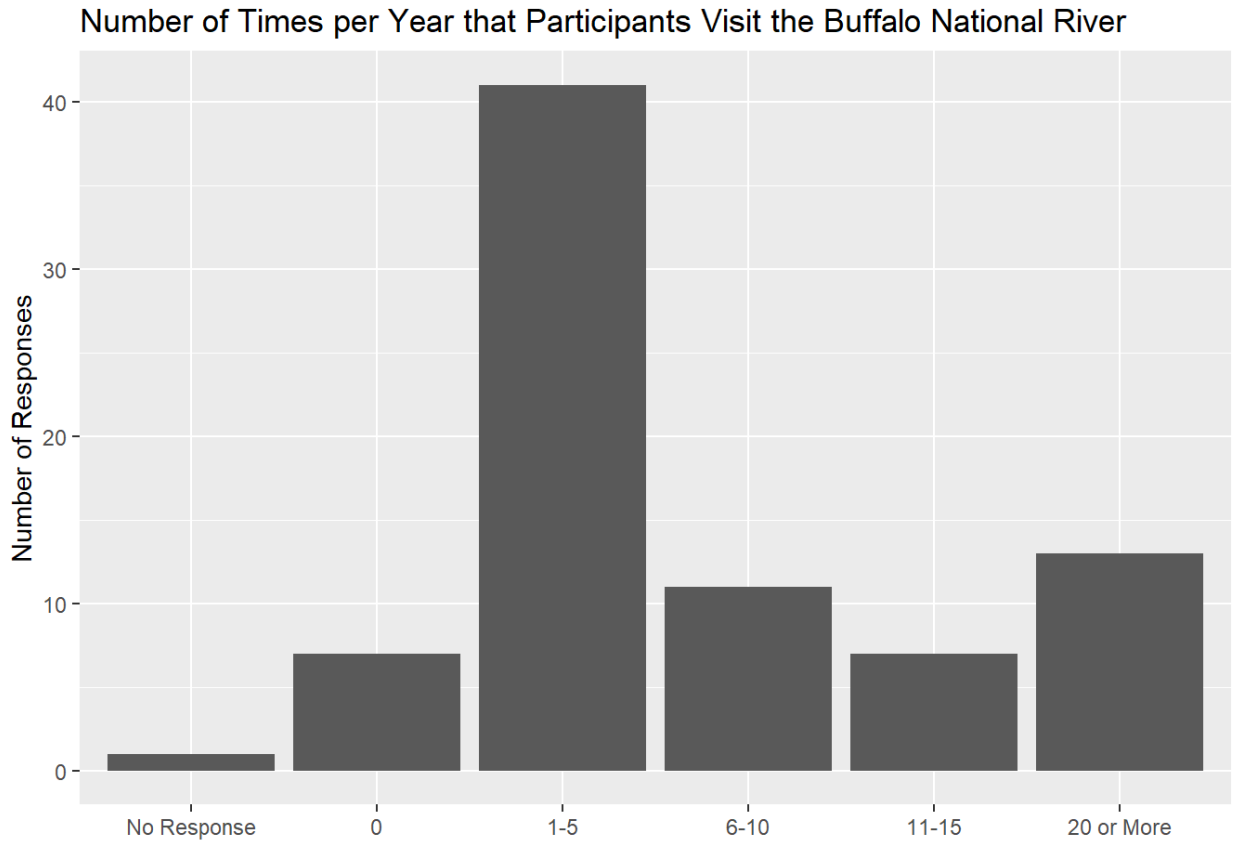


Figure 5.15: Graph representing the number of times per year that participants visited the Buffalo National River. Created in RStudio.

Approximately how many years have you been visiting the Buffalo National River? (Question B2)

Question B2, asking participants to record the number of years that they had been visiting the Buffalo, was an open-ended question designed to gauge participants' potential knowledge or experience in the area. Answers varied from 0 to '50+.' Again, 1% of participants declined to respond. Though question B1 had one category representing just over 50% of the survey population, the answers for question B2 were distributed slightly more evenly. 11% of people surveyed said that they had been visiting the Buffalo for zero years, meaning that this was their first year of enjoying an activity in America's first national river. 35% of people said they had been visiting for 1-5 years. 15% of people had been visiting for 6-10 years, and 21% had been visiting for 11-22 years. From there, the number of years that participants recorded having visited the Buffalo jumps, with 14% of people saying that they had been visiting the river for 30-45 years and 3% saying they have been visitors to the Buffalo for 50 or more years.

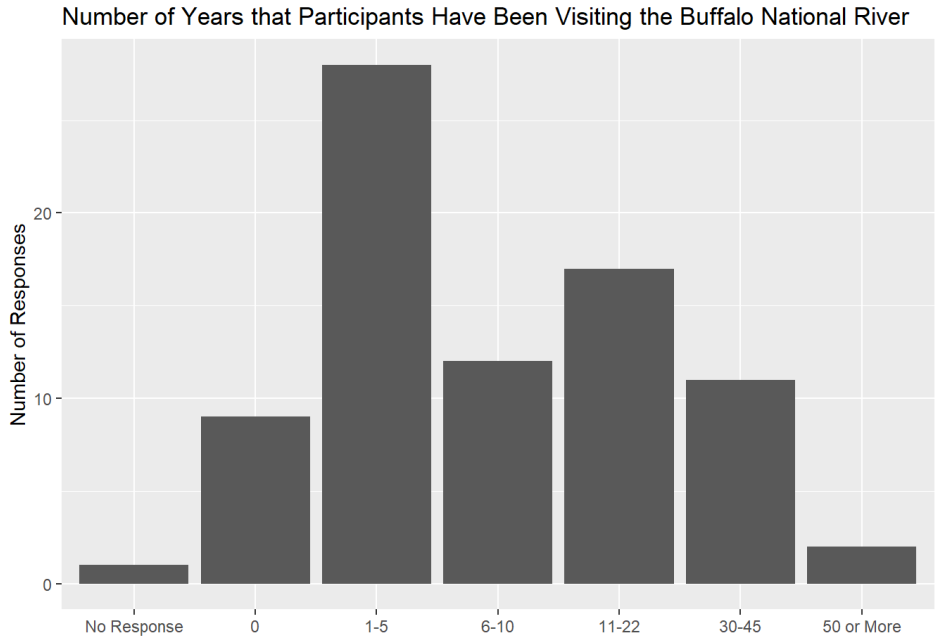


Figure 5.16: Graph representing the number of years that participants have been visiting the Buffalo National River. Created in RStudio.

The Buffalo River became America's first national river in 1972 and this survey took place in 2019. This means that for those 3% that have been visiting the Buffalo for 50 or more years, they likely saw the creation of the official Buffalo National River (Public Law 92-237).

What activity/activities do you participate in? (Question B3)

In question B3, participants were asked to mark the activity or activities that they participated in in the Buffalo National River. Options included kayaking/canoeing, tubing, swimming, day hiking, overnight hiking, car camping, recreation area use, and horseback riding. Participants could also select the box representing 'other,' which gave them the opportunity to write down any activity not mentioned above.

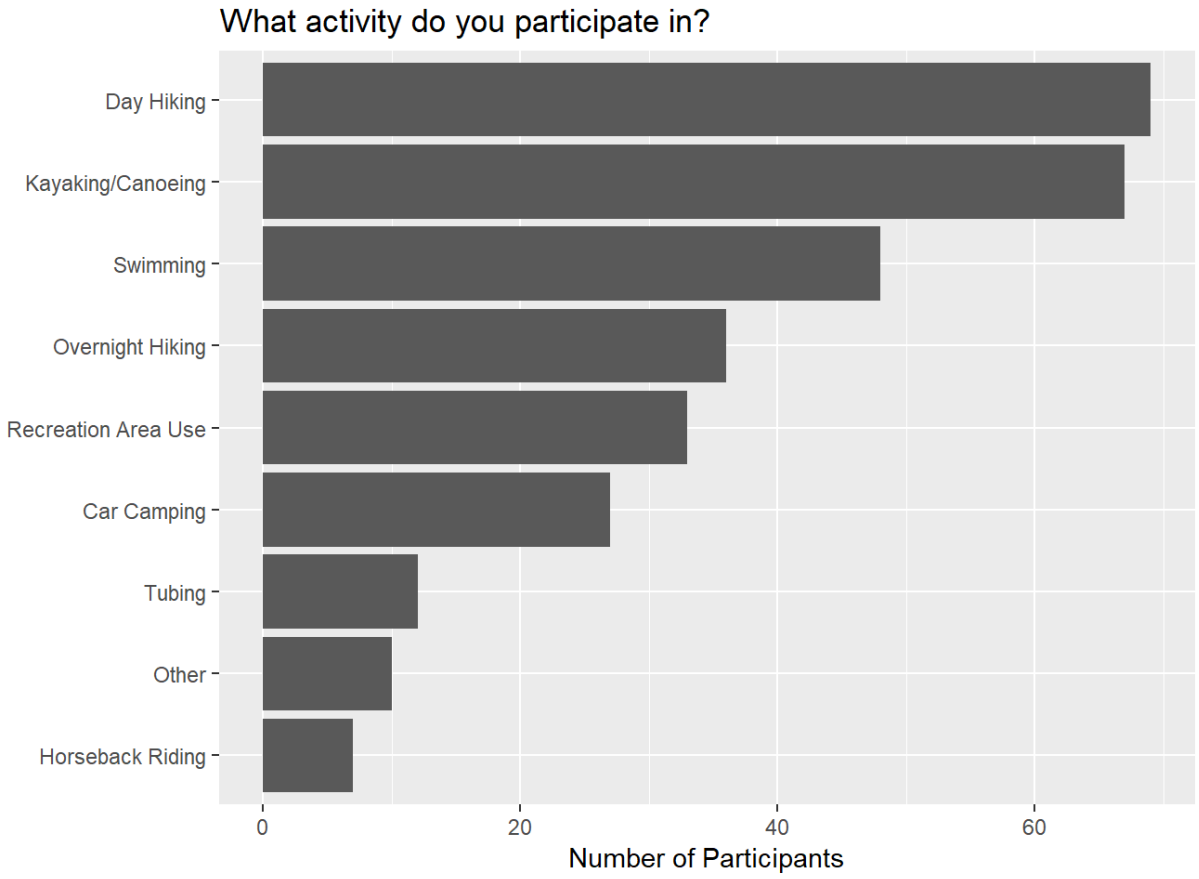


Figure 5.17: Graph representing the number of participants who reported participating in each activity. Created in RStudio.

Participants were asked to mark as many boxes as necessary to accurately represent their participation in activities. 67 people said they went kayaking or canoeing on the river. Only 12 people tubed on the river, and 48 people said they went swimming. The largest group, representing 69 people, said they participated in day hikes. 36 people went on overnight hikes, also known as backpacking. 27 respondents said they car camped, and 33 utilized the recreational day use areas throughout the park. 7 people said they went on horseback rides, and 10 people checked the 'other' box. Of these 10, responses included caving, research, fishing, cleanups, and primitive camping.

How many years have you done said activity/activities? (Question B4)

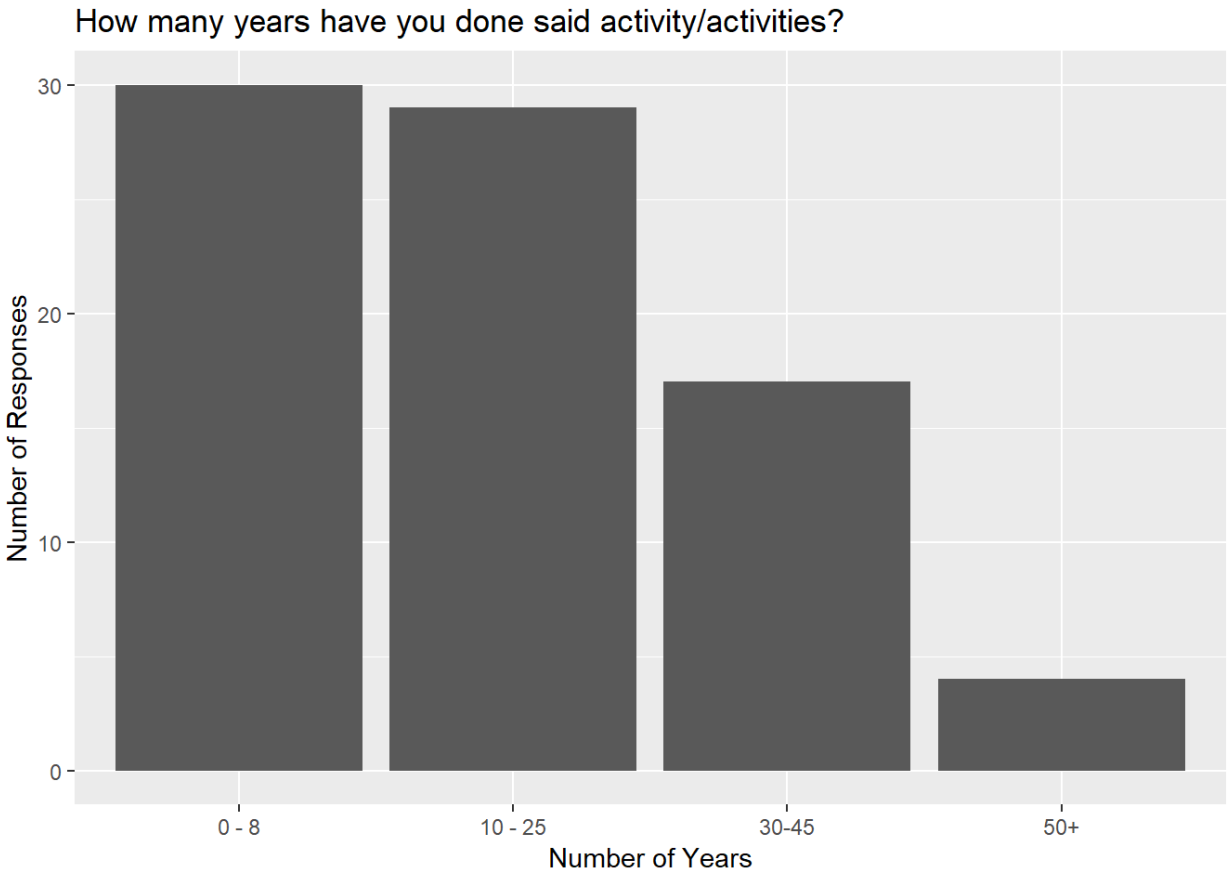


Figure 5.18: Graph representing the number of years participants have been participating in a listed activity. Created in RStudio.

Following the question asking participants to record which activity they partook in was question B4 asking participants to state the number of years of experience they have in whatever activity they marked. The majority of people fell into one of the first two categories: 0-8 (38%) and 10-25 (36%) years of experience. 21% of respondents had been participating in their activity for 30-45 years, and 5% had 50 or more years of experience.

I would say that my skill level is… (Question B5)

Question B5 asked participants to choose a ranking to self-record their skill level with outdoor activities. Participants could check the box on one of three options: beginner, intermediate, or expert. Four people (5%) left no response. 13% said they were beginners and 15% recorded their skill level as expert, but the vast majority of participants (68%) marked their skill level as intermediate.

Because this was a self-recorded answer, there is no way to verify if such a large percentage of people truly possess an intermediate skill level. People who marked themselves as intermediate could have been slightly overconfident with their choice and might actually belong in the 'beginner' category if faced with an actual test of their skills. On the other hand, some people could be being a bit modest, and might actually belong in the 'expert' category rather than the 'intermediate.' Whichever way, participants self-recorded skill level will be telling when compared to their actual knowledge of risks and hazards in the Buffalo National River.

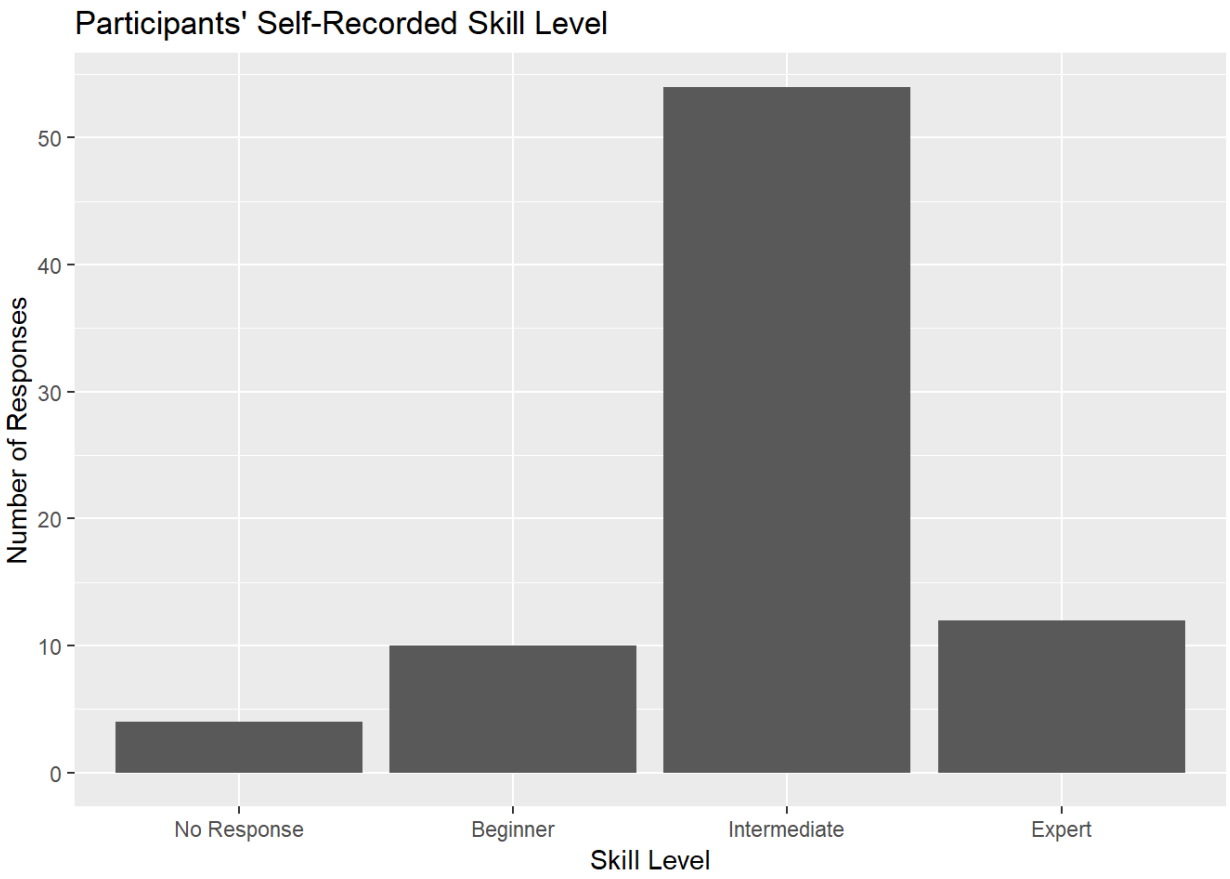


Figure 5.19: Graph representing the self-recorded skill level of survey participants. Created in RStudio.

5-3 – Descriptive Statistics, Questionnaire Section C

Section C asked participants a series of eight questions formatted as a Likert scaled response. Each 'question' was a statement that required participants to respond that they strongly disagreed, disagreed, were neutral, agreed, or strongly agreed. This format – five choices with levels of agreeance, one of which is neutral – is a traditional Likert scale format (Harpe, 2015). It is intended to gauge the perception of participants on a broad topic; in this case, safety and risk in the Buffalo National River.

I always research before doing one of the activities listed… (Question C1)

Participants were first asked to respond to the statement "I always research before doing one of the activities listed." These 'activities' refer back to question B3, when they were asked to

mark which activities they participated in at the Buffalo. There was one no response, which amounts to about 1% of those surveyed. 5% of participants strongly disagreed, meaning that no, they never research before doing one of the activities listed. 6% disagreed with the statement and 21% were neutral about it. Despite this, 48% of participants said they agreed with the statement that they always research before participating in an activity at the Buffalo and 19% strongly agreed.

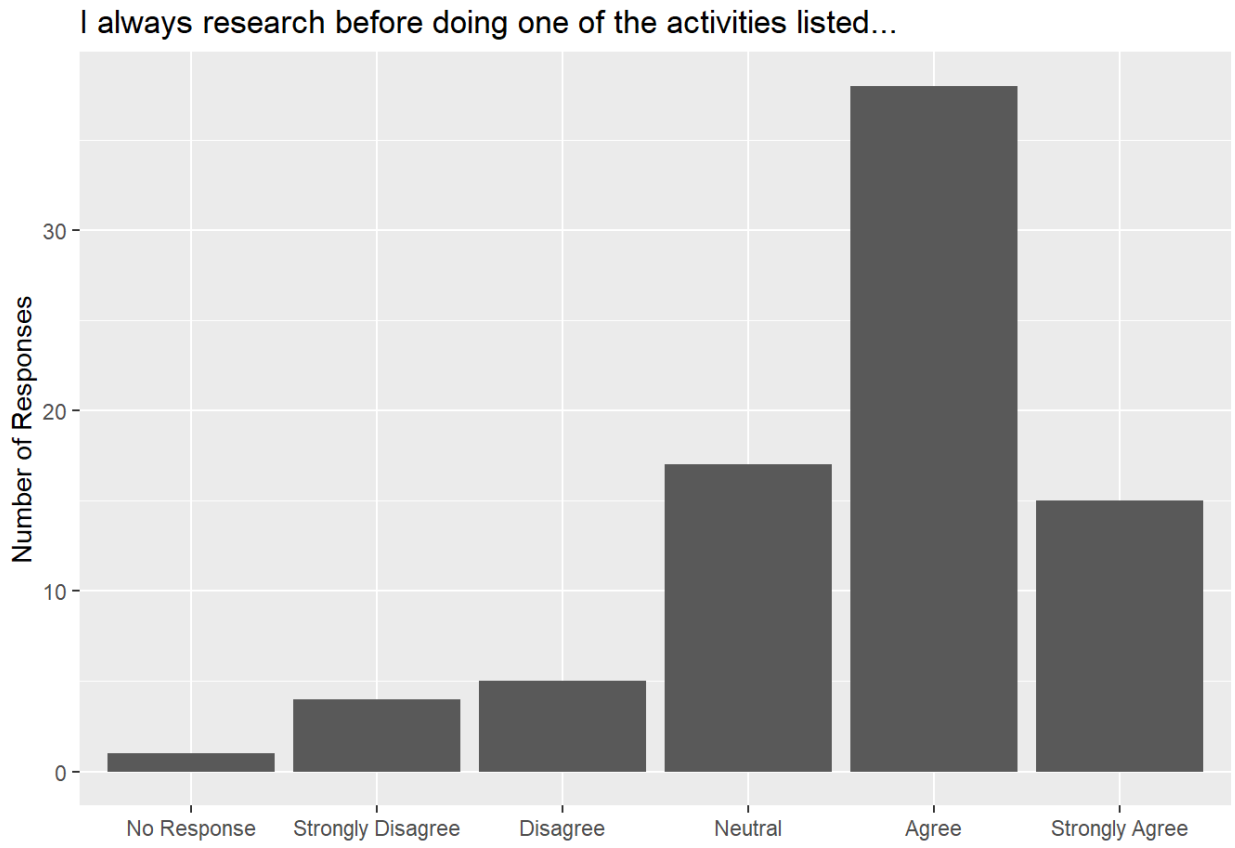


Figure 5.20: Graph representing participants responses to the statement "I always research before doing one of the activities listed." Created in RStudio.

I always wear my life jacket in/on the river… (Question C2)

C2 requested that participants respond to the statement "I always wear my life jacket in/on the river." Responses to this question were less skewed and more evenly distributed than that of question C1. Unlike question C1, and other C questions to come, every participant was

willing to share their opinion on this topic. No participants chose not to respond. 14% strongly disagreed with the statement and 15% disagreed, meaning that 31% of the population surveyed did not always wear their life jacket in or on the river. 25% were neutral on the topic. 26% agreed and 20% strongly agreed, saying that yes, they always wore their life jacket on the Buffalo River.

Though wearing a lifejacket is not mandatory for children and adults over the age of 13 on the Buffalo National River, it is highly recommended. The National Park Service in the Buffalo River has a life jacket loaner program, where visitors may borrow a life jacket from one of three ranger stations along the river free of charge (Life Jacket Loaner Program, nps.gov/buff, 2017). The law requires all vessels on the Buffalo River to have one life jacket per person, and the NPS's preventative search and rescue web page reminds visitors that "it won't work if you don't wear it" (nps.gov/buff).

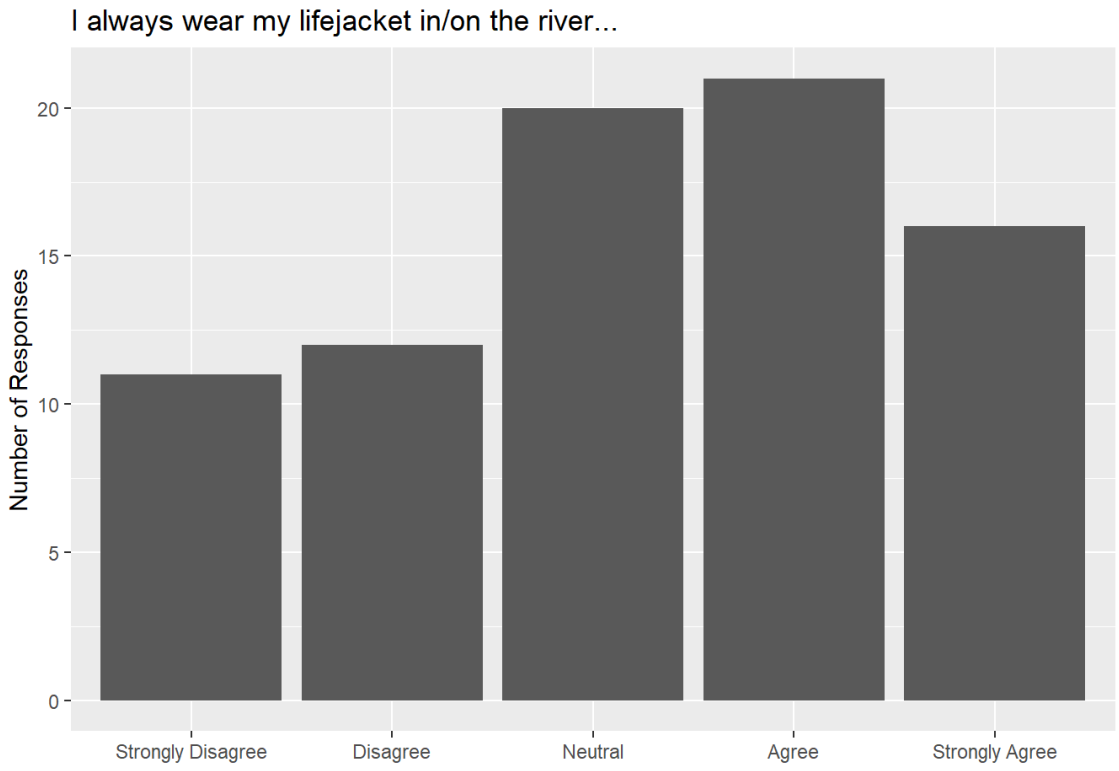


Figure 5.21: Graph depicting participants' responses to the statement "I always wear my lifejacket in/on the river." Created in RStudio.

I always follow warning signs… (Question C3)

Figure 5.22: A series of three photos showing warning signs along the roadside in the Buffalo National River near Ponca, AR.

For question C3, participants responded to the statement “I always follow warning signs.” Warning signs are posted all over the Buffalo National River in an attempt to inform visitor of potential hazards. The photos above depict signs reminding visitors that they should wear their life jackets and to be mindful of flash flooding and river hazards. According to the responses to question C3, visitors pay attention and heed signs such as these. 3% of participants declined to respond, and 4% each said they strongly disagreed or disagreed with the statement. 20% of participants were neutral on the subject, but 41% agreed and 29% strongly agreed that they always follow warning signs.

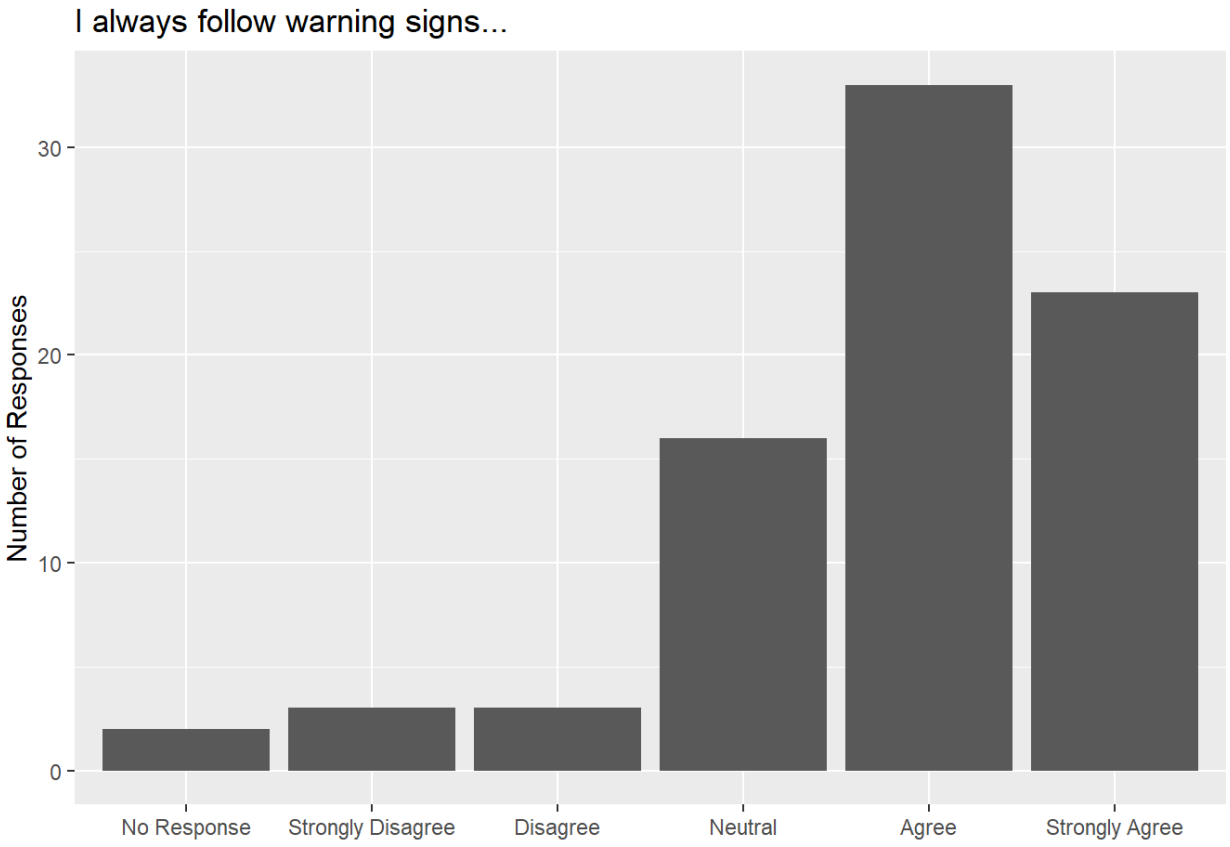


Figure 5.23: Graph showing participants' responses to the statement "I always follow warning signs." Created in RStudio.

The information presented by the National Park Service is useful… (Question C4)

Responses to the statement "The information presented by the National Park Service is useful" in question C4 were very positive. The majority of respondents said that they strongly agreed (40%) or agreed (44%). 13% of the surveyed population remained neutral on the matter, and there were no 'disagree' responses. 3% of people, however, strongly disagreed that the information presented by the NPS was useful. 1% of participants declined to respond.

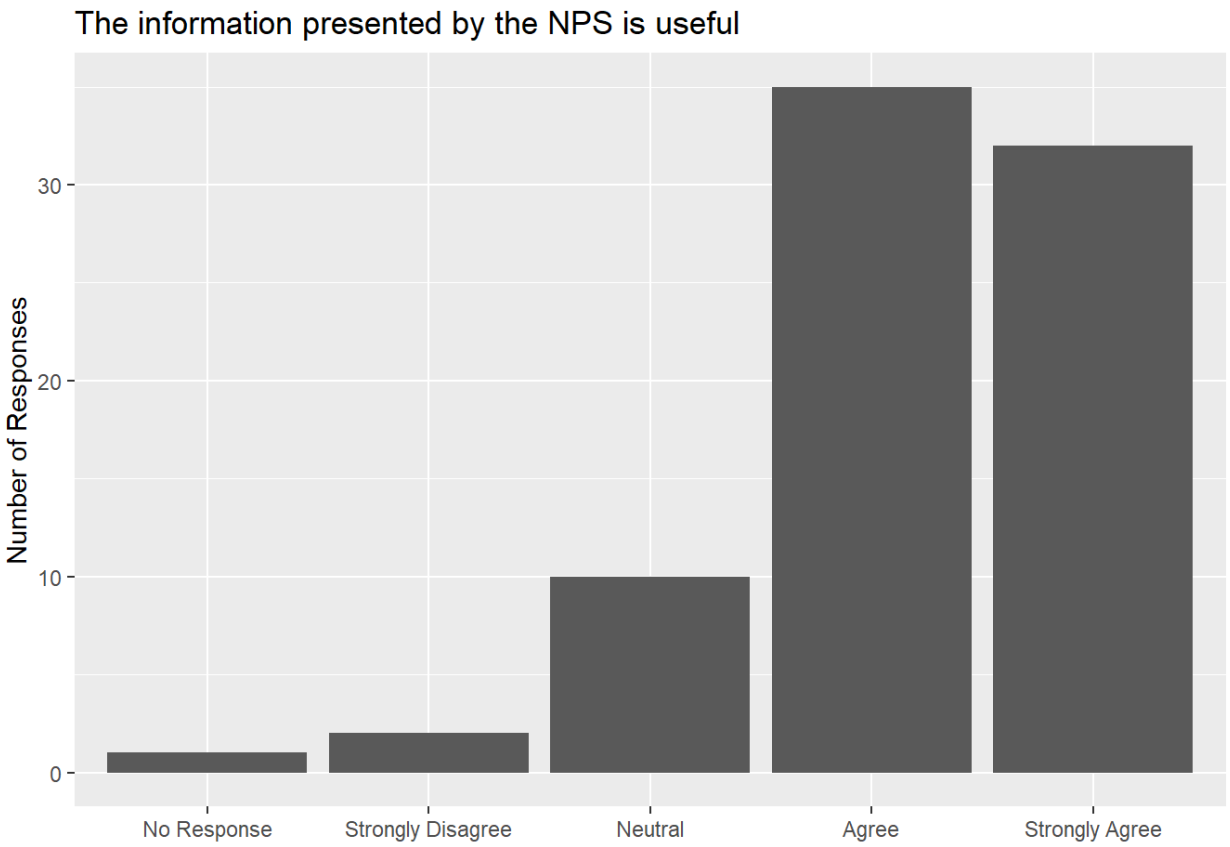


Figure 5.24: Graph representing participants' agreeance with the statement "the information presented by the National Park Service is useful." Created in RStudio.

I have a plan in case of injury… (Question C5)

For question C5, participants were asked to respond to the statement "I have a plan in case of injury." Admittedly, this statement is extremely broad. 'Injury' could range anywhere from a bruised knee to a broken neck. Regardless of the severity of a potential injury, it is always smart to have a plan. 4% of people surveyed said they strongly disagreed with the statement, and 10% disagreed. 13% were neutral. 41% agreed that they had a plan in case of injury, and 30% strongly agreed. 3% of participants declined to respond.

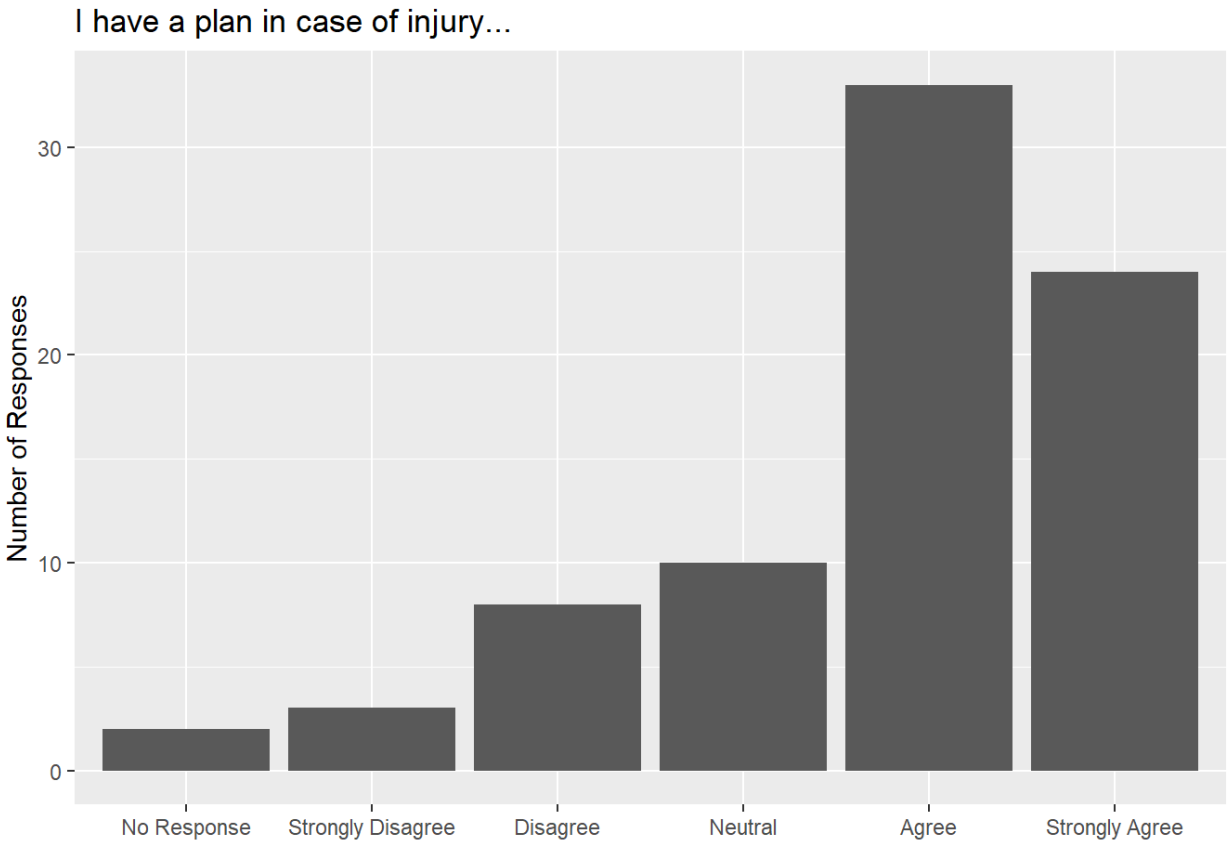


Figure 5.25: Graph depicting the responses participants recorded to the statement "I have a plan in case of injury." Created in RStudio.

I have a plan for personal evacuation… (Question C6)

The statement for C6, "I have a plan for personal evacuation," was also meant to be a broad question. Visitors to any national park need to be ready to help themselves out of a difficult situation, since emergency response times in national parks can be lengthy. For all national parks in 2012 and 2013, the average time between when the dispatch call went out to when authorities arrived on scene was 33:28 minutes (Lane, Taylor, Smith, & Wheeler, 2015). This average, however, refers to the time it took emergency medical personnel to get to the scene. It would not include other wait time that could be involved in a search and rescue, such as time waiting to be found or the time it takes a lost person to find cell phone service to call for help.

1% of participants declined to respond to the statement, and 6% strongly disagreed with it. 11% disagreed, meaning that no, they do not have a plan for personal evacuation. 23% were neutral, 44% agreed, and 15% strongly agreed. Having a plan for personal evacuation is a necessary part of any trip or activity planning.

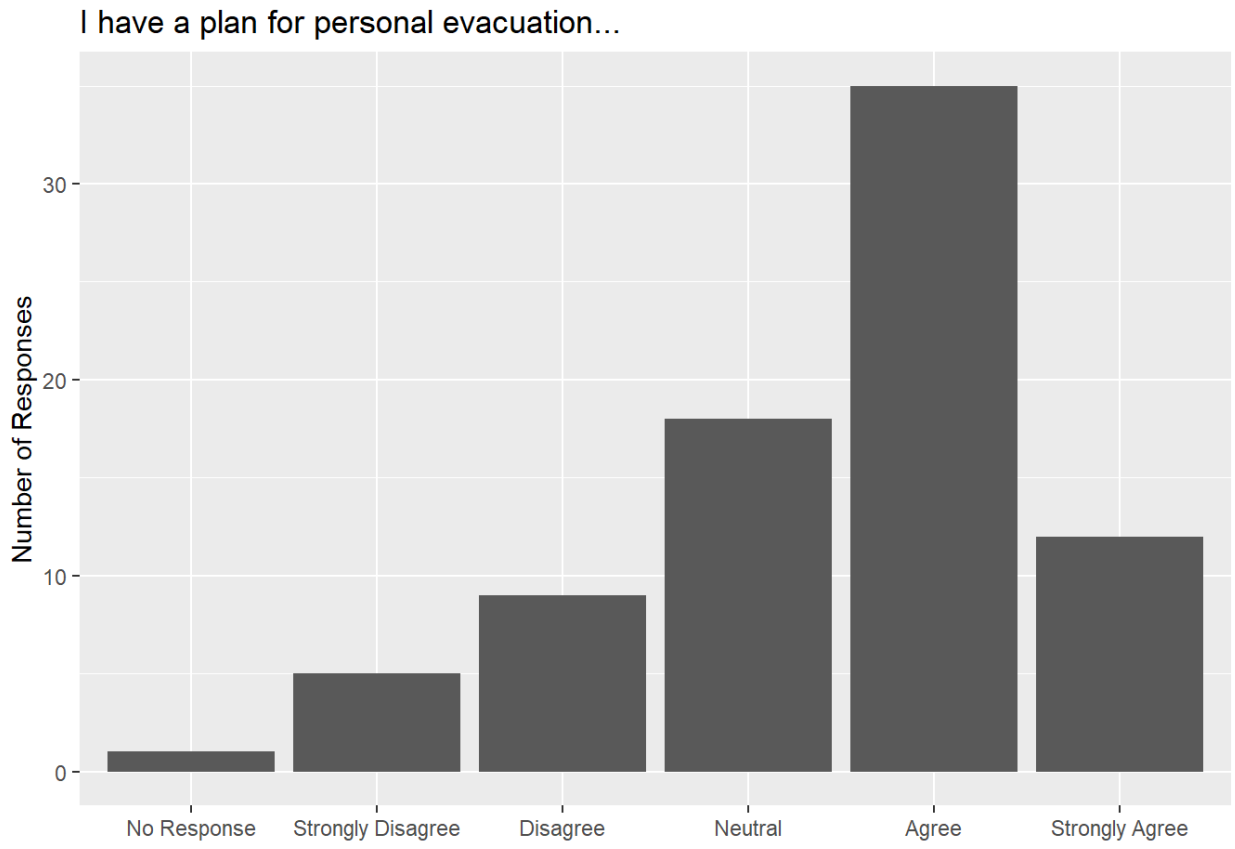


Figure 5.26: Graph showing how participants responded to the statement "I have a plan for personal evacuation." Created in RStudio.

I am concerned about cell phone service… (Question C7)

In question C7, participants were asked to record their level of agreeance with the statement "I am concerned about cell phone service." Many people visit national parks in an attempt to unplug and are thankful that cell phone service is spotty. While being disconnected is definitely an excellent way to experience nature, in the event of an emergency cell phones can

potentially mean life or death because of the possibility of using them to call for help. The responses to this question, when compared to others in the Likert scale section, were more evenly spread and slightly more divisive. Most people had an opinion one way or the other. Besides 1 no response representing 1% of the survey population, the neutral category was the lowest group with only 11%. 23% agreed and 16% strongly agreed that yes, they are concerned about cell phone service. 21% strongly disagreed and 28% disagreed, meaning that they are not concerned about cell phone service.

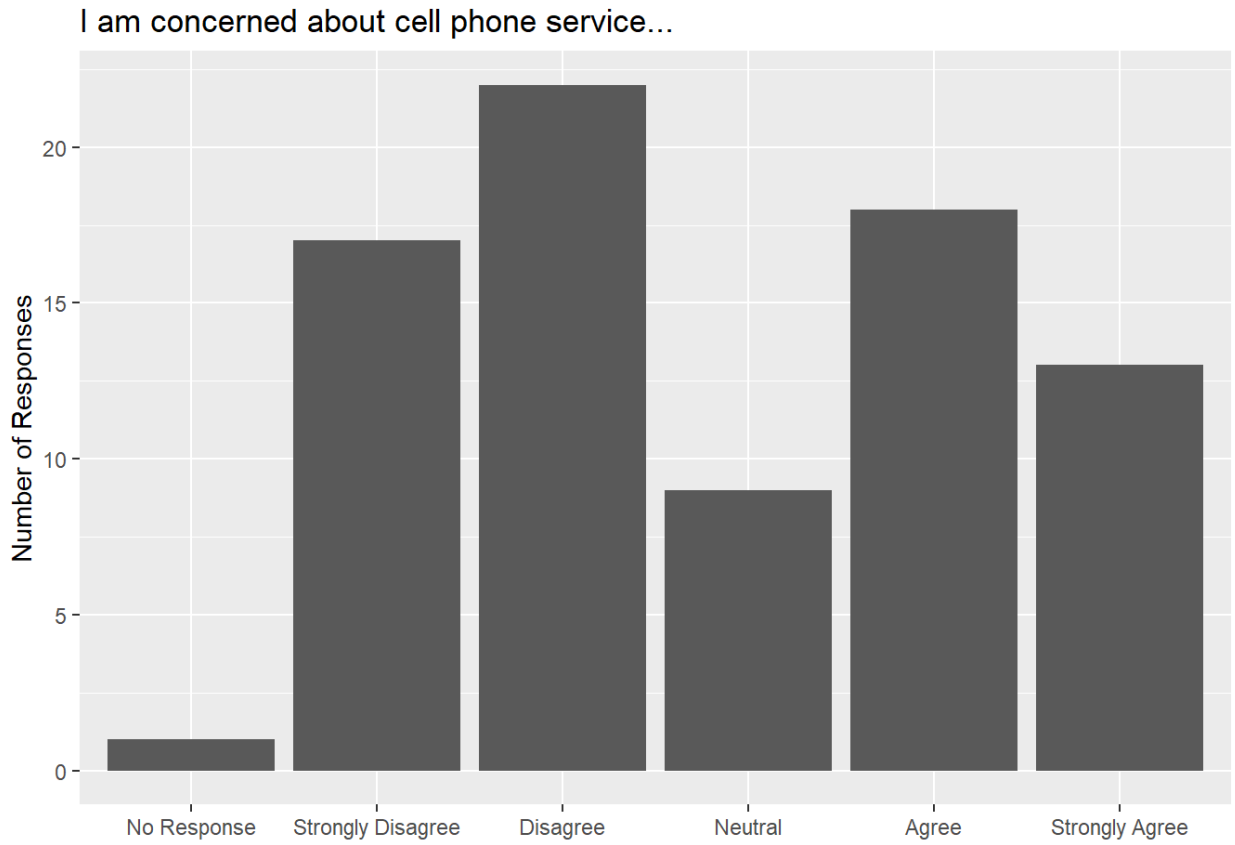


Figure 5.27: Graph depicting participants level of agreeance with the statement "I am concerned about cell phone service." Created in RStudio.

I am aware of safety resources available to me… (Question C8)

The responses to question C8, "I am aware of safety resources available to me," were slightly skewed left, leaning towards general agreeance or neutrality with the statement. 1% declined to respond, 4% strongly disagreed, and 13% disagreed with the statement. 26% were neutral, 40% agreed, and 16% strongly agreed.

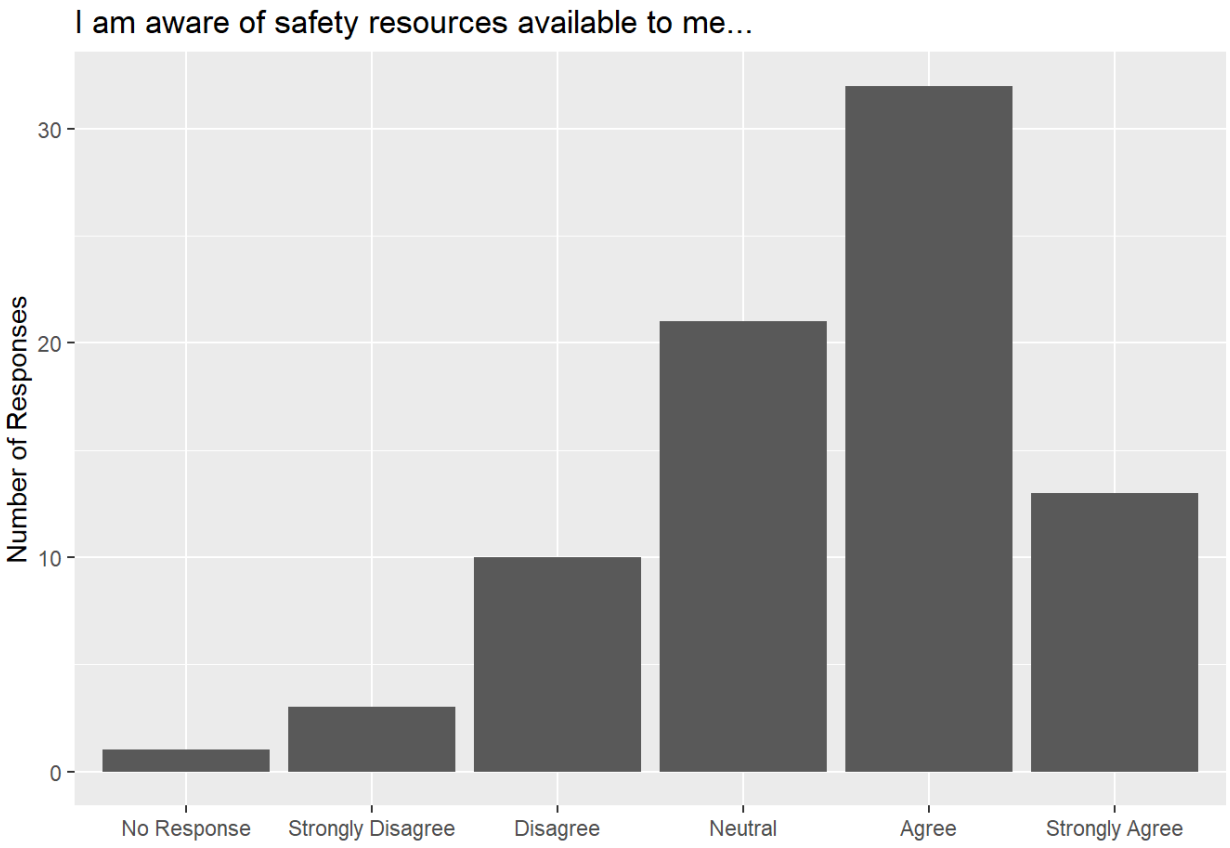


Figure 5.28: Graph depicting participants' agreeance with the statement "I am aware of safety resources available to me." Created in RStudio.

Please list all safety resources that you are aware of… (Question C9)

Though Figure 5.28 showing the graph of responses to question C8 indicates that a large number of respondents were in agreeance with the statement that they were aware of safety resources available to them, the responses to question C9 indicates that only just under

half of the surveyed population knew enough to write any safety resource down. The open-ended format to question C9 allowed participants to write down as few or as many safety resources that they could think of. 48% of respondents wrote down at least one safety resource, but 52% left the section blank or wrote an answer indicating that they were not aware of any.

The most popular responses listed park rangers, emergency services, and law enforcement as primary safety resources. Answers involving ‘park rangers’ or the ‘NPS’ occurred a total of 23 times. Emergency services, including 911, was mentioned 14 times, and law enforcement were cited 8 times. Though park rangers of course help provide information on an everyday basis as well as help during an emergency, the other two are likely who would be called as an emergency is ongoing. Others listed more simple resources for preventative efforts, such as making good decisions or researching at the library or on the internet before embarking on an adventure. Other safety resources listed included bringing extra supplies, consulting or contacting local volunteers, cell phones, maps, warning signs, or loud whistles.

5-4 – Descriptive Statistics, National Park Service Search and Rescue Data

Buffalo National River, 2011 – 2017

With the help of Mr. Louie Stoops of the Buffalo National River main office in Harrison, Arkansas, data were transcribed into excel from the National Park Service’s emergency services reporting program. In total, the Buffalo National River’s rangers and other emergency personnel responded to 164 search and rescue calls from 2011 to 2017. Of those emergency calls, only 146 were for search and rescue events within park boundaries.

Terrain Where SAR Occurred

Because the Buffalo National River has abundant recreational activities on land and on the river, emergency responders must be knowledgeable about rescues in both terrains. From 2011 to 2017, the slight majority (55%) of search and rescue events occurred on the river.

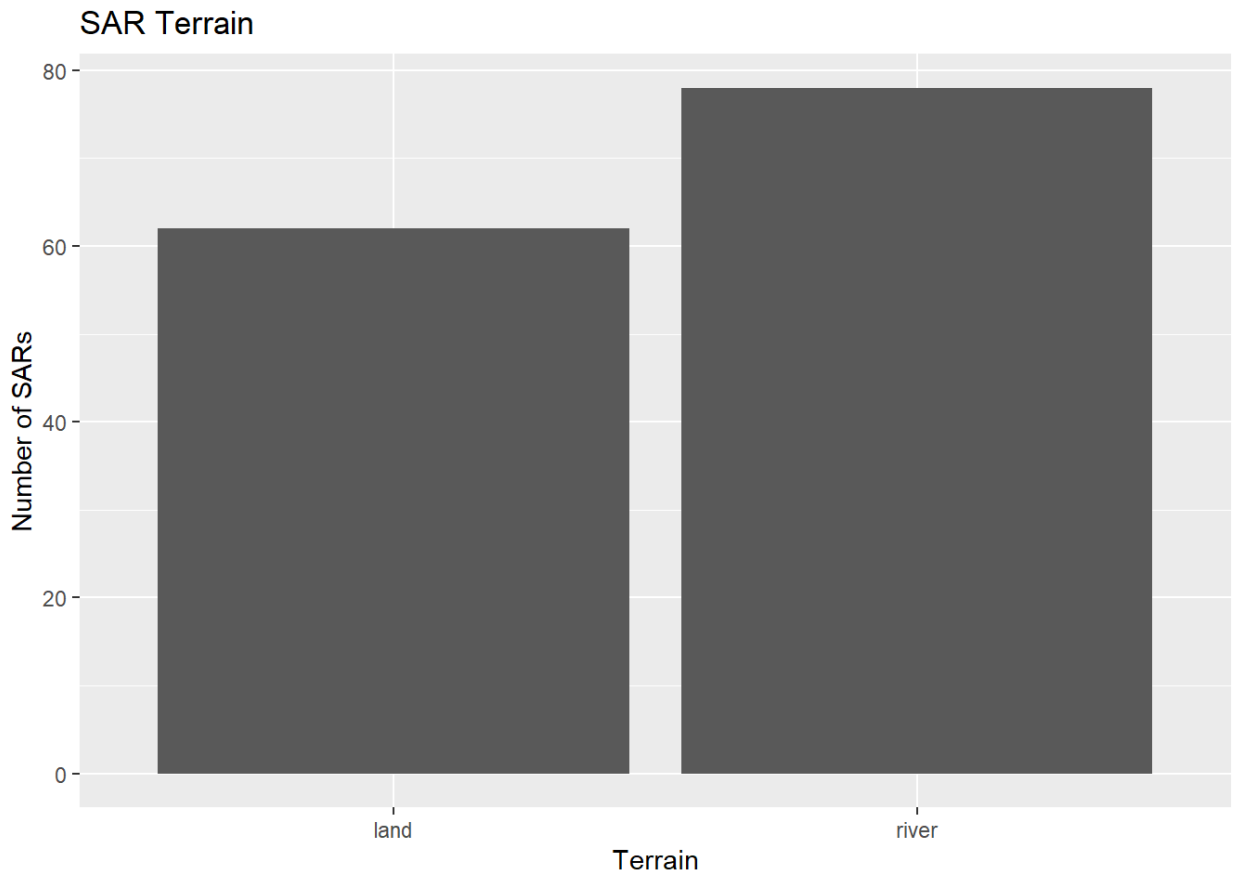


Figure 5.29: Graph representing the number of SARs located on land or on the river. Created in RStudio.

Location of SAR Events

Though NPS emergency staff responded to some events outside park boundaries, this study is only concerned with those SAR events that occurred within the Buffalo National River. Of those, the location with the most SAR events was Big Bluffs at 15 events between 2011 and 2017. The lowest number of SARs represented on this graph is one event, but there are many other locations within the BNR that were not the location of any emergencies. Hemmed-in-Hollow, Steel Creek, and Big Bluffs are all in the Upper Buffalo, at the park's western edge.

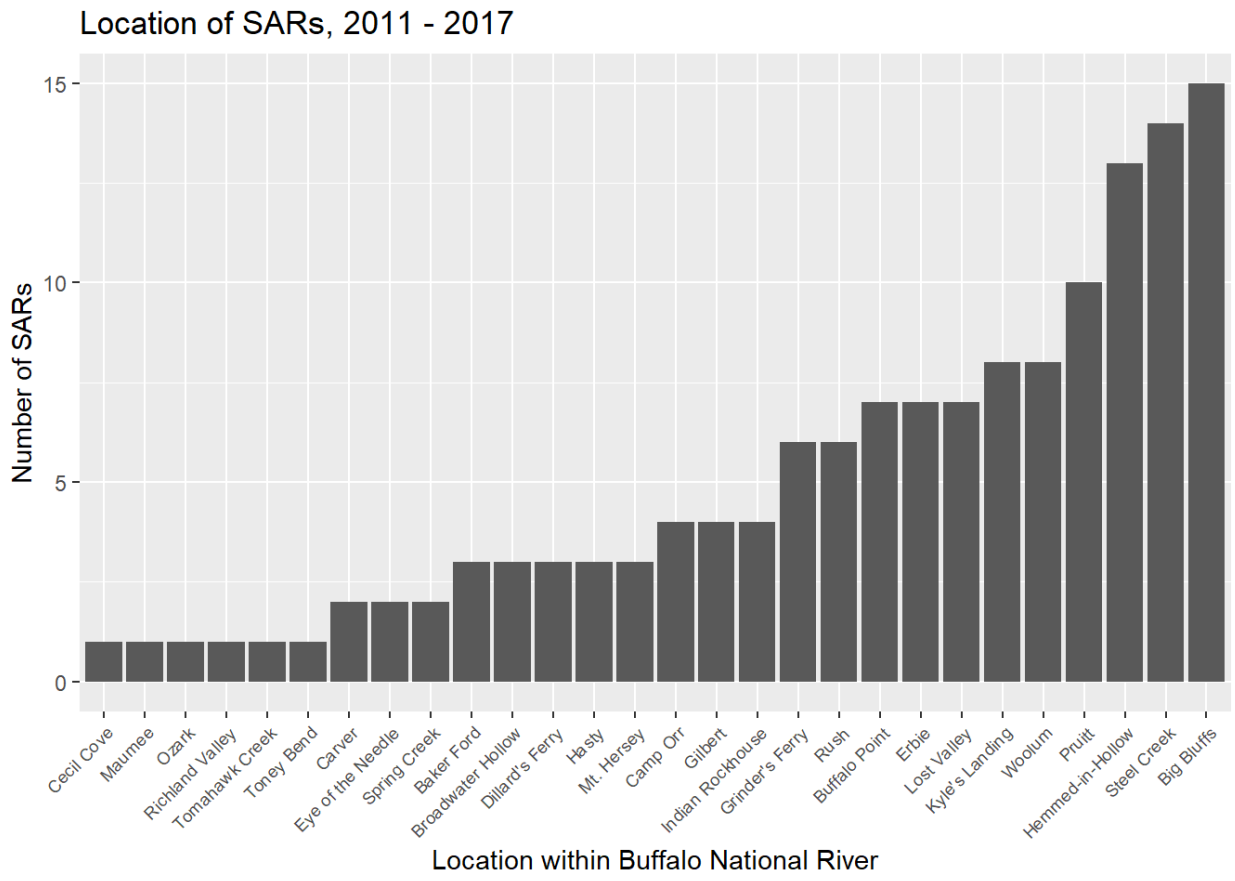


Figure 5.30: Graph depicting the number of SAR events that occurred between 2011 and 2017 in each location on the Buffalo National River. Created in RStudio.

Age of Victims

The data were gathered from the National Park Service's reports on SAR events. These reports are filled out by the rangers and first responders who were on scene. Most reports did not include the age of the victim, so the unknown age category is quite high. Of those that did have a recorded age, the majority of victims were age 29 or younger.

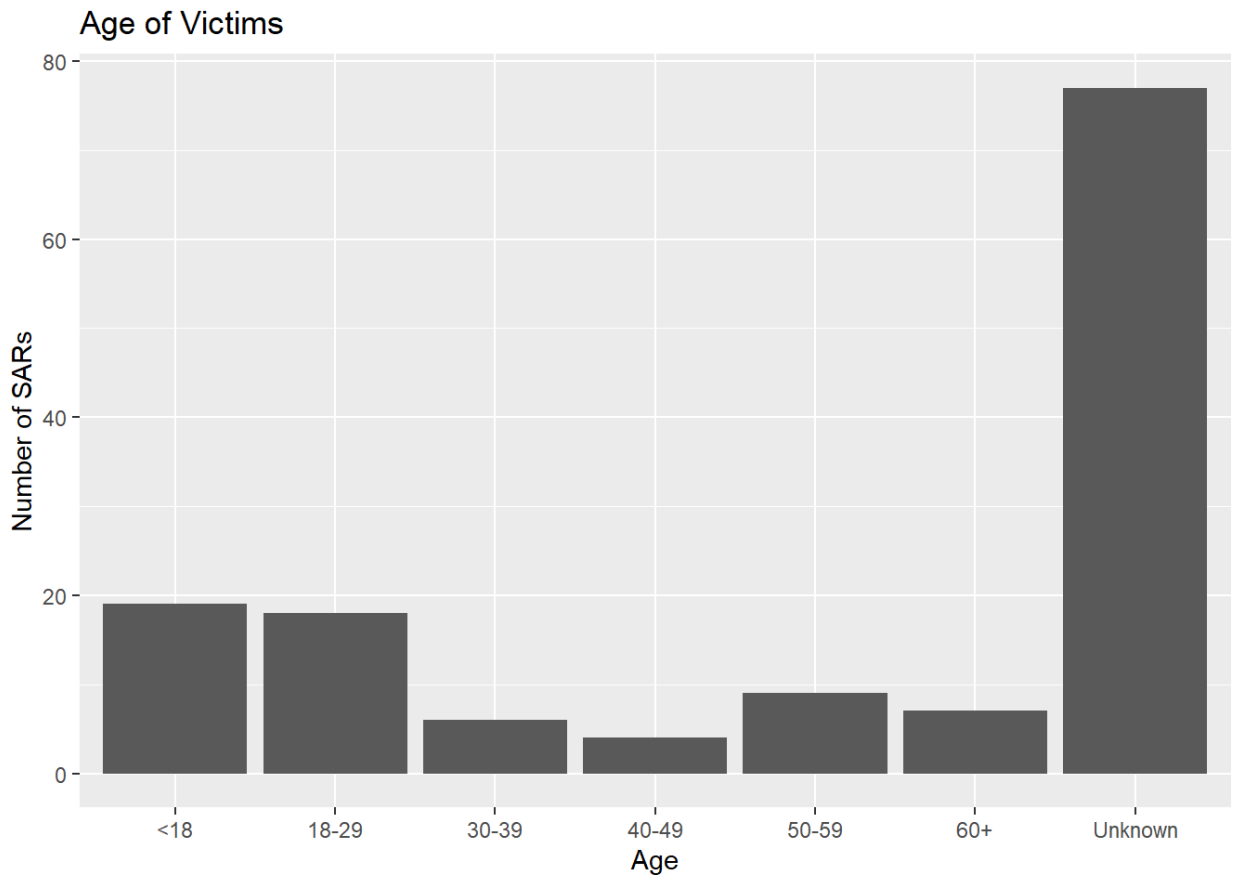


Figure 5.31: Graph depicting the age of victims involved in search and rescue missions. Created in RStudio.

Sex of Victims

As with the ages of victims, a victim's sex was not always noted on the SAR record. Of those that did mention the sex, 56% of victims were female and 44% of victims were male.

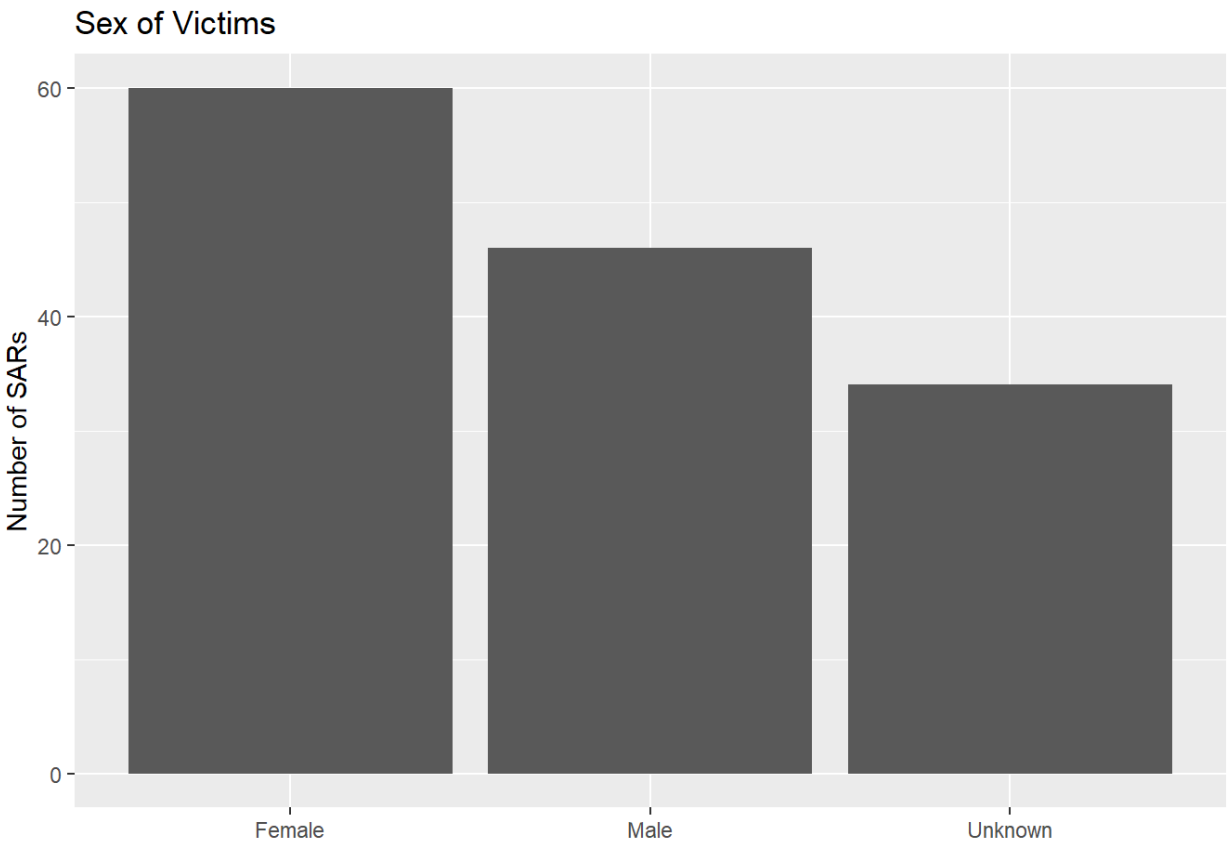


Figure 5.32: Graph representing the sex of victims as recorded by the emergency responders on scene. Created in RStudio.

5-5 – Statistics Mapped

For ease of analysis, the questionnaire was broken up into sections labeled A – G. "Section F" is the section dedicated to mapping. Participants were presented with a blank map of the Buffalo National River and were instructed to "please mark an 'X' on the area or areas you think are the most dangerous. Please do not mark more than 5 locations."

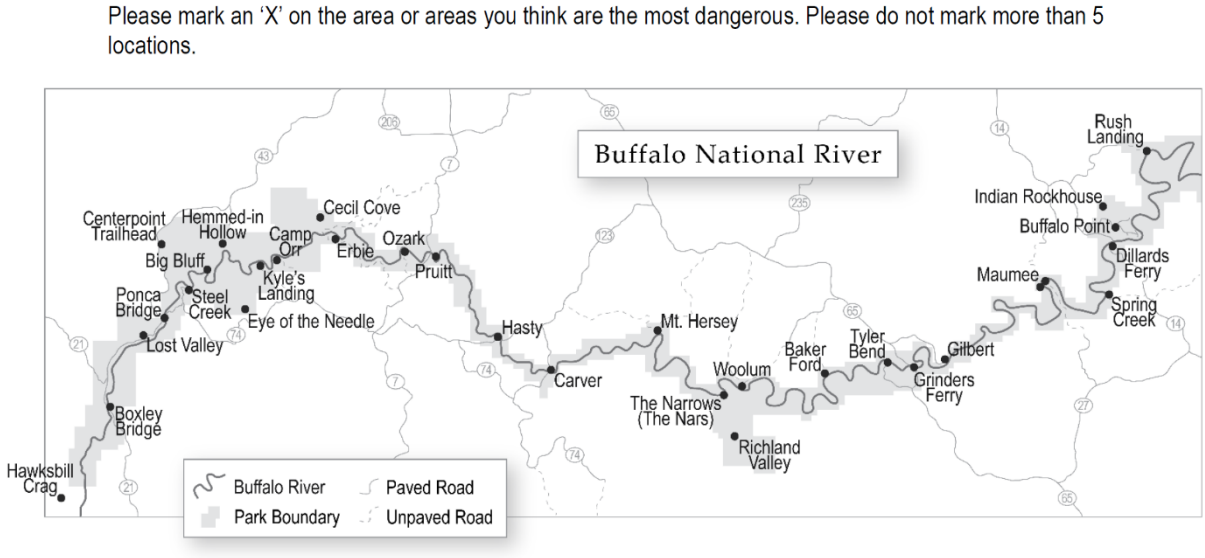


Figure 5.33: Clipping of Section F from the questionnaire.

The locations labeled on the map were chosen based off of information available on the park's website. River checkpoints were taken from a flier and dry land locations were chosen based on the 'Things to Do' tab of nps.gov/buff. Though participants could have marked any location on the map, most chose to draw an 'X' over a labeled location. Four labeled locations – Erbie, Hasty, Carver, and Grinder's Ferry – were not marked as dangerous on any of the 80 completed surveys.

Some locations labeled on the questionnaire map were later merged for data analysis or left out. Hawksbill Crag was left out of data analysis because it is not located in the Buffalo National River. It was included on the map for reference and locational awareness but was not meant to be marked. In future studies, it should not be labeled so it is not mistaken for a possible choice. Locations that were on the same trail or excess river markers were combined with the nearest and most logical location. The Centerpoint Trailhead data were combined with the data for Big Bluff because they are both on the same trail. Boxley Bridge were combined with the data for Lost Valley because they are both located in the old Boxley township. Ponca

Bridge data were combined with Steel Creek data because of their close spatial proximity and near sameness colloquially.

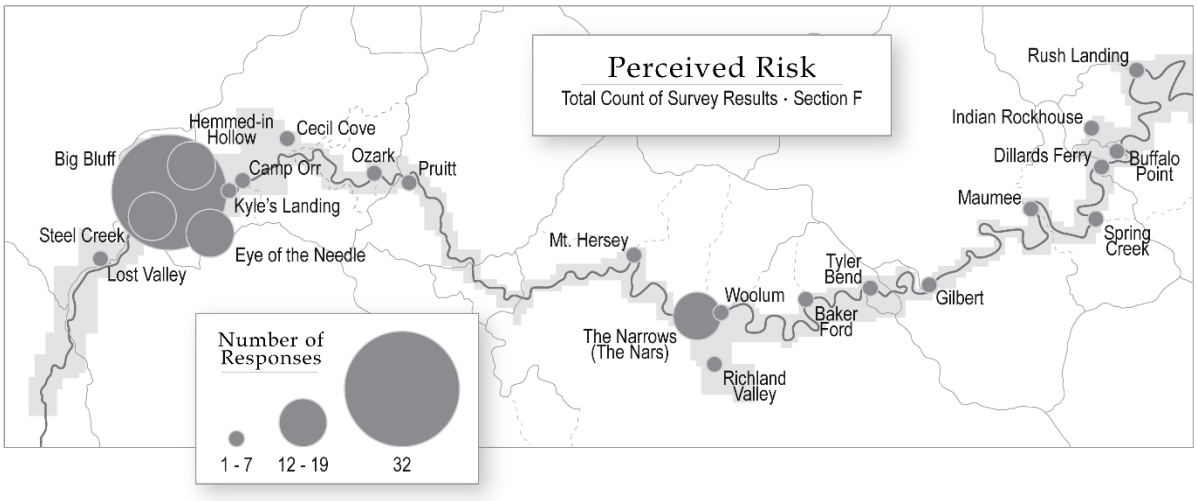


Figure 5.34: Map representing the number of times a location within the Buffalo National River was marked as an area of risk by survey participants.

After initial data counts were assessed, Section F was mapped in comparison to other questions on the survey. Analysis was done using pivot tables in excel, then percentages were calculated for each data point in each question to create sectored coin maps.

Is your current place of residence urban, suburban, or rural? (Question A6)

Figure 5.35 reveals that a large percentage (62%) of participants classify their current place of residence as urban or suburban. The majority of urban dwellers marked areas in the Upper and Middle Buffalo as risky. Though ma

ny (78%) of the participants who marked Big Bluff as an area of risk currently live in an urban or suburban setting, only a small percentage (22%) of rural dwellers marked Big Bluffs as risky. The same can be said for Hemmed-In-Hollow and Eye of the Needle, but half (50%) of the participants who marked Steel Creek as risky were from a rural area.

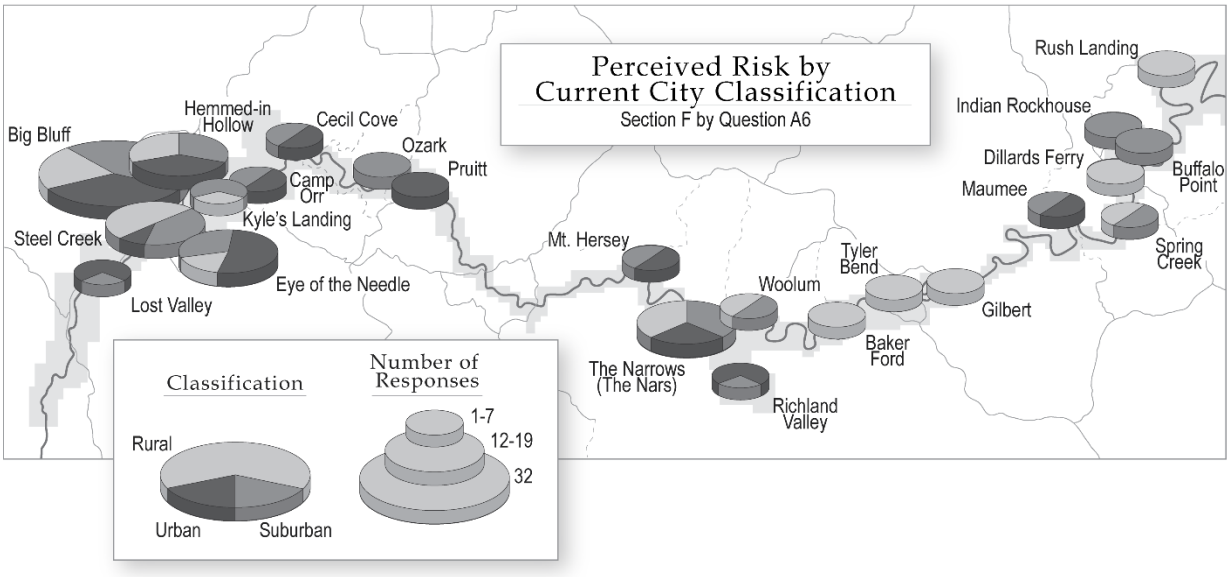


Figure 5.35: Map depicting perceived risk in the Buffalo broken down by current place of residence classification.

The Northwest Arkansas Region is largely considered urban and suburban, especially compared to much of the rest of the state. The westernmost portions of the park were generally marked as potentially risky by urban and suburban dwellers. This could be attributed to the fact that the western part of the Buffalo National River is only a short drive from the relatively urban towns of Fayetteville, Springdale, Rogers, and Bentonville.

Education Level (Question A8)

When mapped by education level, the data appears to be fairly uniform. Of the five locations with the most ‘X’s (Big Bluff, Hemmed-in-Hollow, Steel Creek, Eye of the Needle, and the Narrows), education level percentages look to be similar. In the case of the Buffalo, education level may not have an effect on perception of risk. This is important to know when creating a strategy to inform visitors of potential risks.

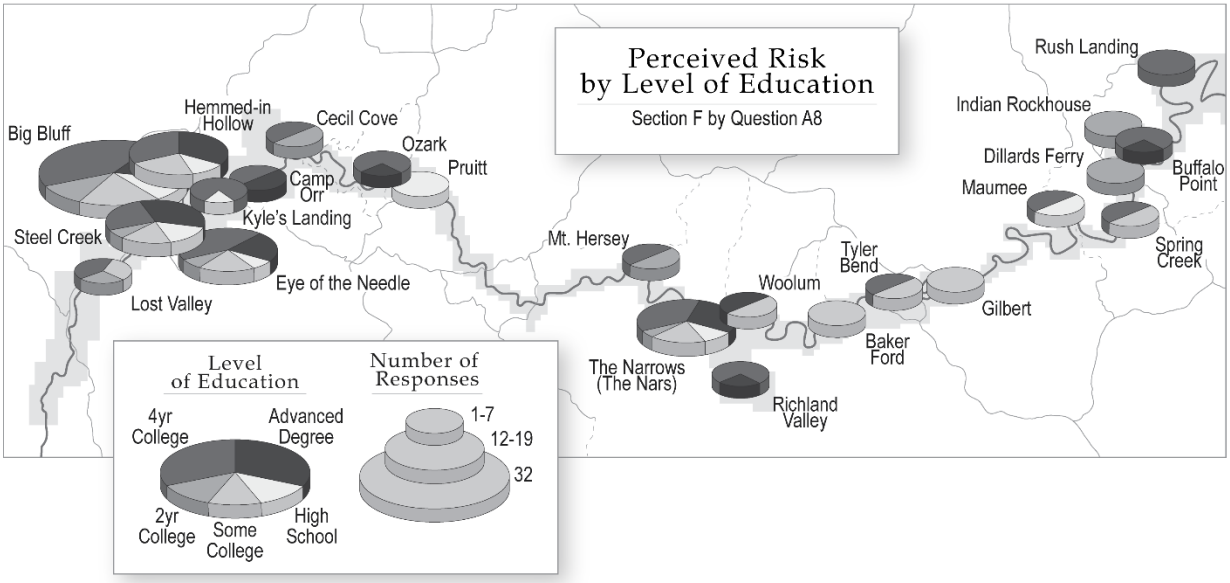


Figure 5.36: Map depicting participants perception of risk mapped by their education level.

Income Level (Question A9)

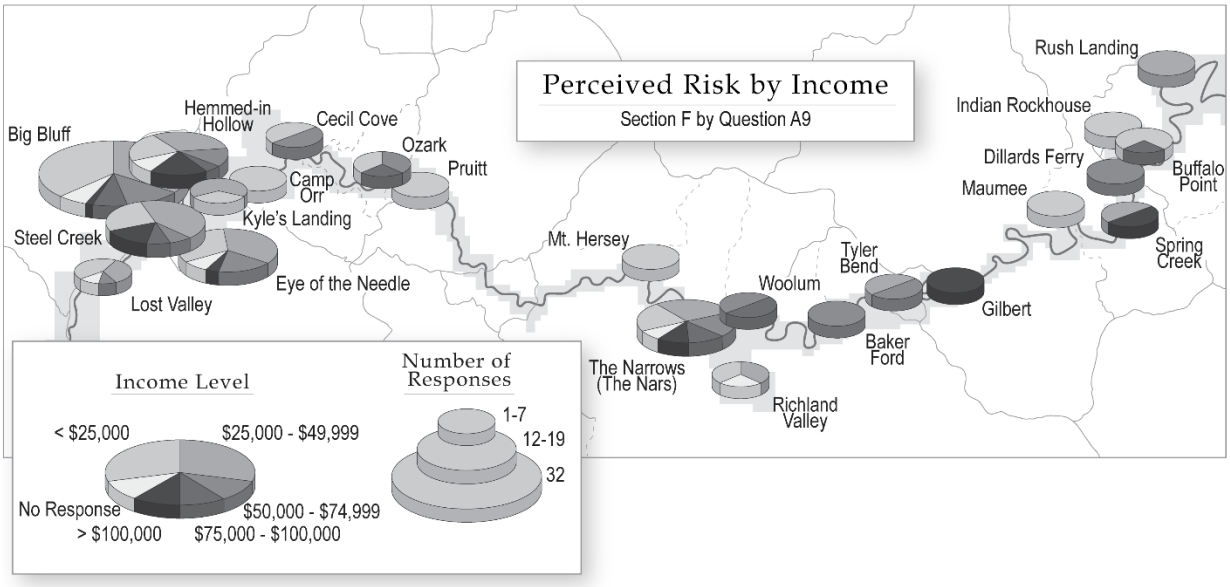


Figure 5.37: Perception of risk in the Buffalo National River mapped by participants' income level.

This map appears to be largely dominated by lighter colors representing lower income levels. This is because the majority of participants fall into one of the lower categories (see Figure 5.5). However, the percentages of each income level on each coin are interesting. Just over two thirds (65%) of participants who marked Big Bluff as dangerous had an income of $49,999 or less, but that number drops down to around half for the areas of Hemmed-in-Hollow (47%) and The Narrows (47%). Likewise, nearly 20% of participants who marked Hemmed-in-Hollow as dangerous had an income of greater than $100,000, but only around 5% of that same category believes that Big Bluff is dangerous.

Do you smoke or vape? (Question A11)

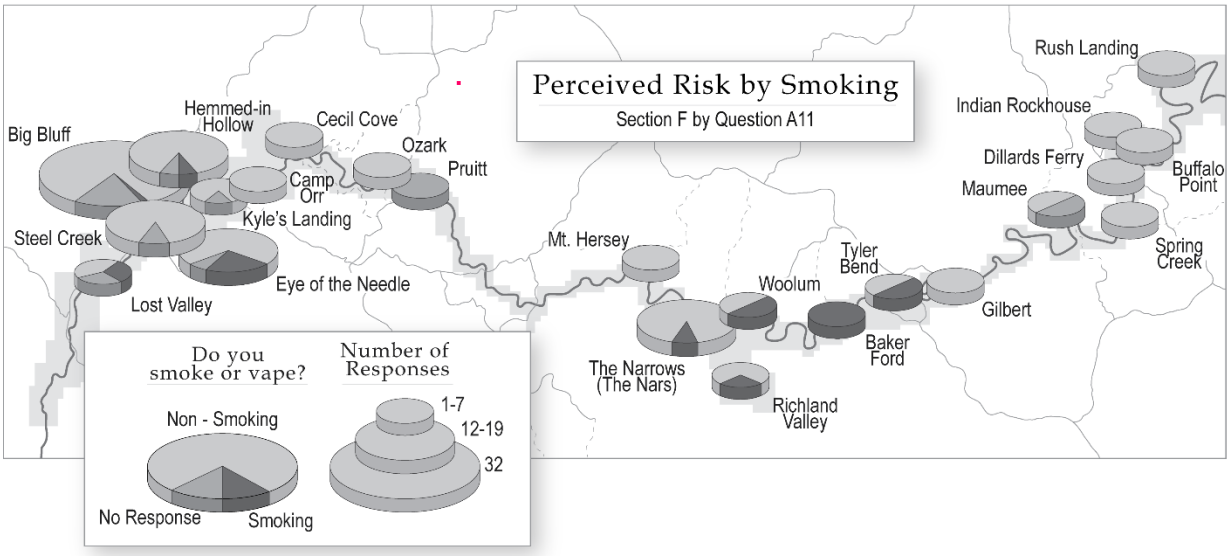


Figure 5.38: Map of risk perception in the Buffalo National River as perceived by smokers and non-smokers.

Participants who admitted to smoking or vaping seem to believe that the riskiest areas in the Buffalo National River are in the Upper or Middle river only. None of the smokers surveyed selected anywhere in the Lower Buffalo as an area of potential risk. According to the data

gathered, a larger percentage of smokers (24%) believe that the Eye of the Needle is dangerous.

Self-reported skill level (Question B5)

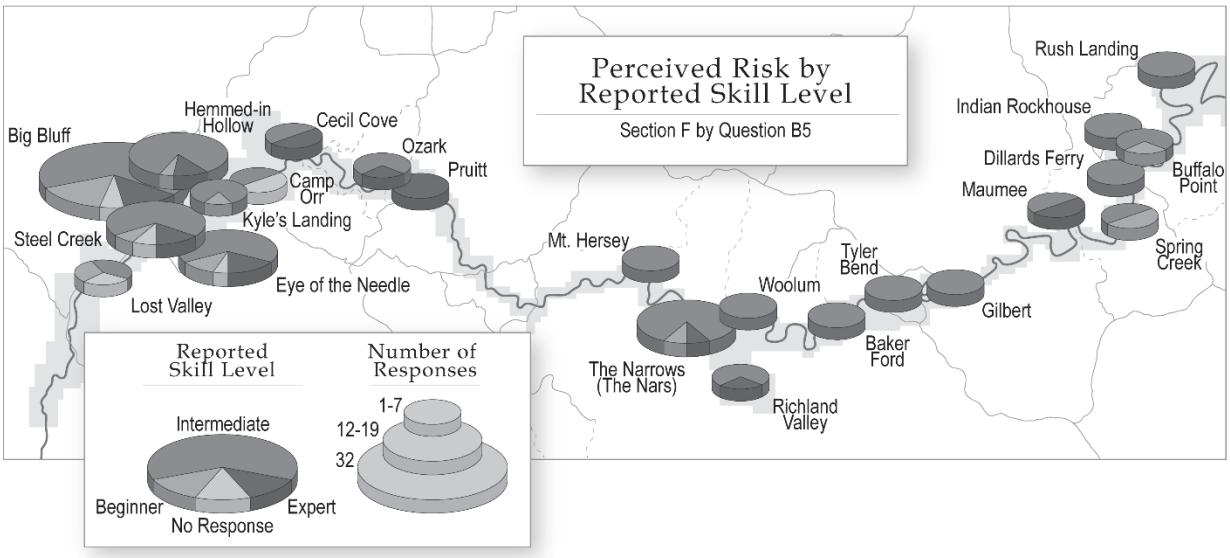


Figure 5.39: Perceived risk in the Buffalo mapped by self-reported outdoor skill level.

In question B5, participants were asked to choose what skill level, in regard to activities performed in the Buffalo National River, they believed themselves to be. The survey gave participants a choice of 'Beginner,' 'Intermediate,' or 'Expert,' and it was completely their choice – no qualifications were given for any of the levels. The majority of participants (68%) claimed that they were of intermediate skill level, as evidenced by the map above. However, few people marked themselves as beginner or expert. Of those few who marked themselves as beginner or expert, generally places in the Upper Buffalo were chosen as areas of risk.

I always research before doing one of the activities listed… (Question C1)

This statement, "I always research before doing one of the activities listed," began Section C on the survey. Before it was Section B, which listed numerous possible activities that

one could do in the Buffalo National River. The majority of the people surveyed were in agreeance or strong agreeance with the statement (67%). Of those who strongly disagreed, areas in the Upper Buffalo as well as two in the middle and one in the lower Buffalo were chosen as areas of risk.

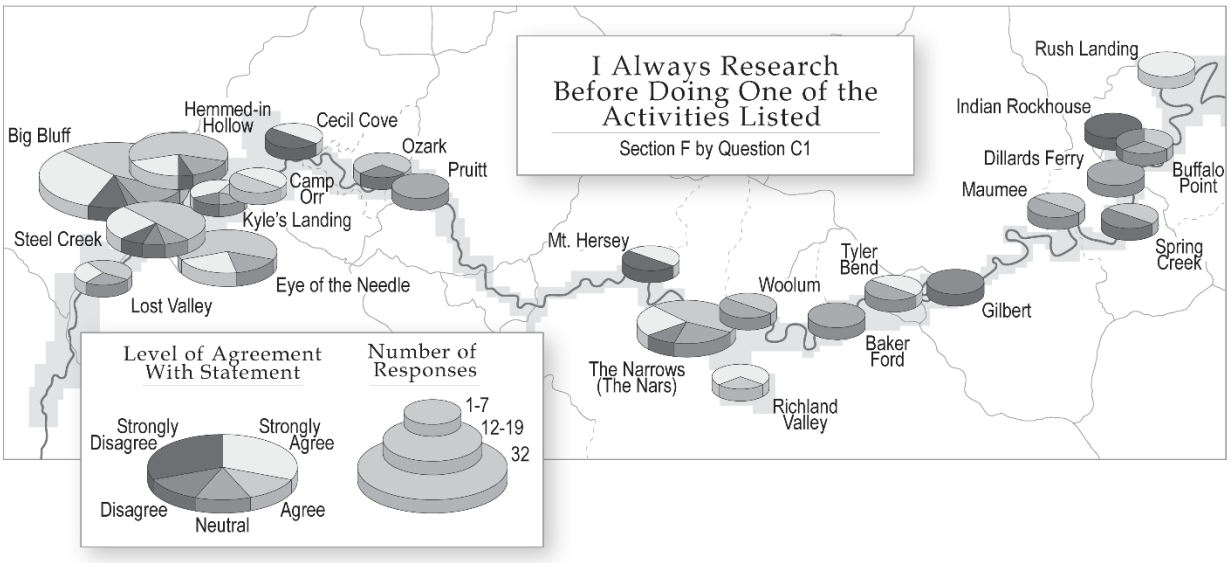


Figure 5.40: Mapped agreeance with the statement "I always research before doing one of the activities listed" compared with participants' risk perception.

I always wear my lifejacket in/on the river… (Question C2)

The National Park Service makes it clear that everyone should wear their life jacket when on the river, but not everyone surveyed agreed with that idea. While hiking trails to get to areas such as Eye of the Needle or Big Bluff might not require a life jacket, areas on or near the water such as Baker Ford, Tyler Bend, Gilbert, Spring Creek, and Dillard's Ferry certainly do. Unfortunately, up to 100% of participants who marked these areas as dangerous also strongly disagreed with the statement "I always wear my life jacket in/on the river."

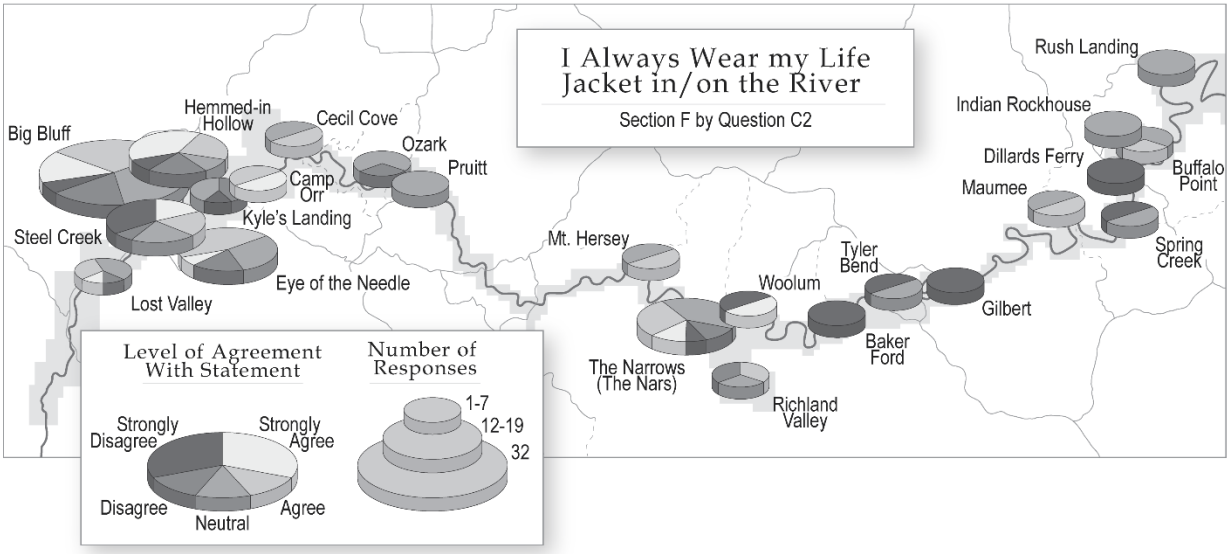


Figure 5.41: Risk perception in the Buffalo National River mapped by agreeance with the statement "I always wear my life jacket in/on the river."

I always follow warning signs… (Question C3)

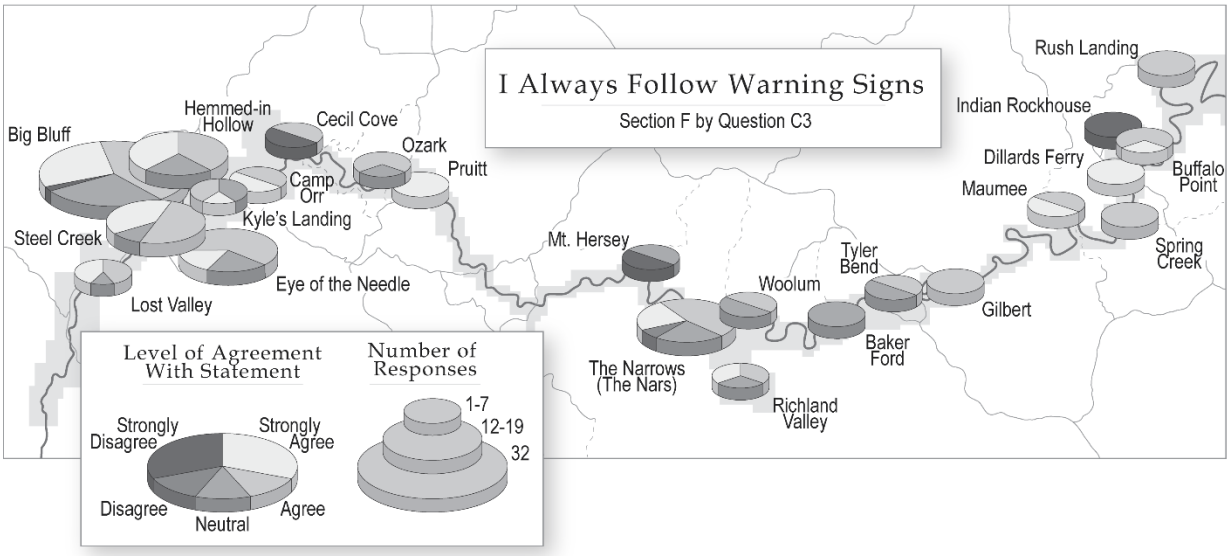


Figure 5.42: Perception of risk mapped by agreeance with the statement "I always follow warning signs."

Most of this map appears to be lighter colors, indicating that the majority (70%) of people surveyed were in agreeance or strong agreeance with the statement "I always follow warning

signs." Only a small percentage (3%) of those who perceive Big Bluffs to be a risky area strongly disagreed with the statement. A few participants who strongly disagreed with the statement marked Cecil Cove (50%), Mt. Hersey (50%), and Indian Rockhouse (100%) as dangerous, but all were dispersed and do not reveal a trend.

Interestingly, no participant simply disagreed with this statement. People either strongly disagreed, were neutral, agreed, or strongly agreed, but of the eighty people surveyed, no one marked disagree. This could be a topic that few want to admit their wrongdoings on and instead mark 'neutral' even if they do indeed ignore warning signs.

I have a plan in case of injury… (Question C5)

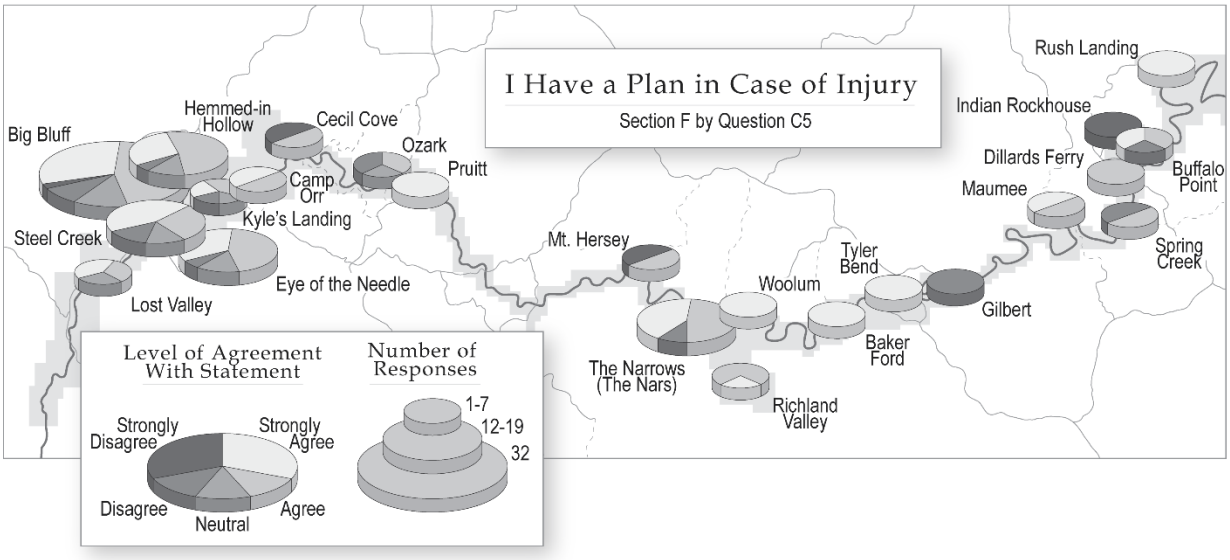


Figure 5.43: Perception of risk mapped by agreeance with the statement "I have a plan in case of injury."

The vast majority of survey participants (71%) either agreed or strongly agreed with the statement "I have a plan in case of injury." A large percentage of participants who marked Big Bluffs as an area of risk strongly disagreed, disagreed, or were neutral about the statement (25%).

I have a plan for personal evacuation… (Question C6)

Though plenty of participants said they did indeed have a plan for personal evacuation, many participants either strongly disagreed or disagreed with the statement (17%), admitting that they were potentially underprepared for their outing. The Buffalo National River is a relatively connected park with decent roads and relatively quick emergency response times, but that does not mean that emergency services will be easy to contact. In such cases, a personal evacuation plan could be crucial.

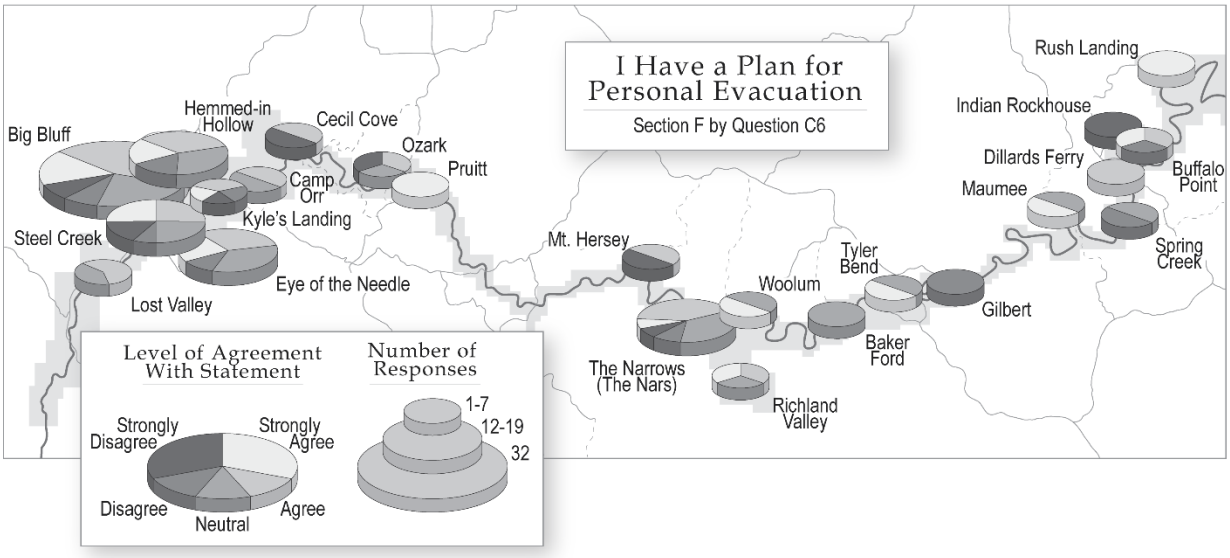


Figure 5.44: Map representing survey participants' agreeance with the statement "I have a plan for personal evacuation" compared to their perception of risk throughout the park.

I am concerned about cell phone service… (Question C7)

The majority of survey participants either strongly disagreed (21%) or disagreed (28%) with the statement "I am concerned about cell phone service." One participant wrote in the comment section to "please keep it wild." Cell phone service would certainly diminish the wildness of the park, but it would potentially increase the safety of visitors. Visitors in peril could more easily call emergency services, or perhaps visitors who find themselves lost could more

easily navigate themselves out of trouble. The National Park Service has a major dilemma in regard to cell phone service, but the majority of this survey's participants (60%) are not concerned.

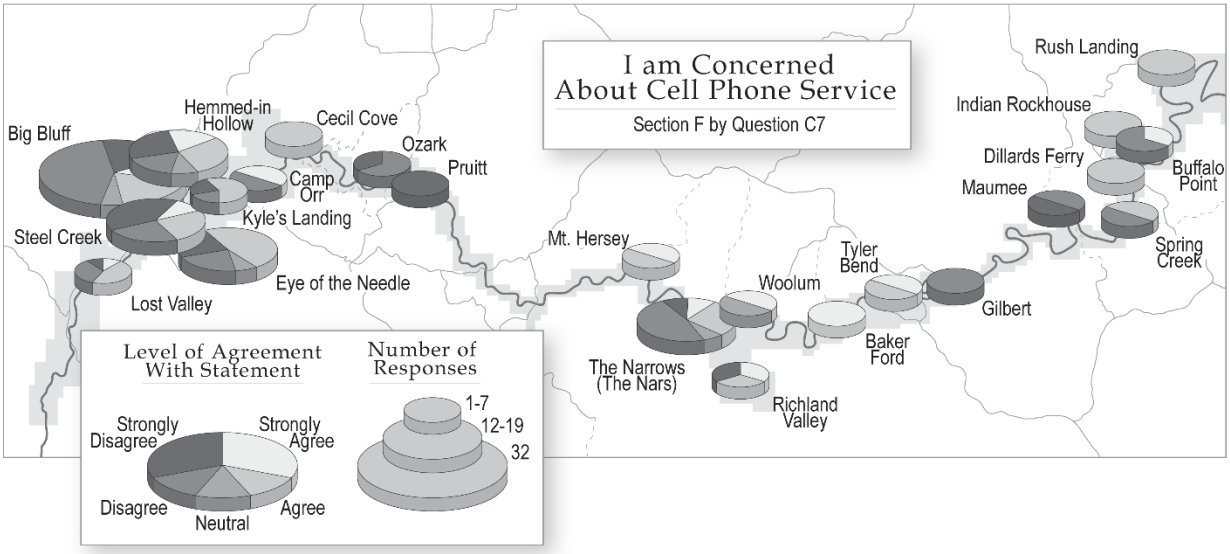


Figure 5.45: Participants' agreeance with the statement "I am concerned about cell phone service" mapped against their perception of risk throughout the Buffalo National River.

Although some participants either strongly disagreed (4%) or disagreed (13%) with the statement "I am aware of safety resources available to me," the majority of them said that they agreed (40%) or strongly agreed (16%). However, the next question asked participants to "please list all safety resources that you are aware of" and few could comply. The most frequent responses were rangers or emergency services such as police or calling 911. While calling 911 is the best thing to do as an emergency is unfolding, it does little to prevent the emergency from ever happening. Rangers are an excellent resource for learning everything about the park; they can give you instructions on how to do an activity safely, give you information about the Buffalo, or tell you where to go, among others. Utilizing resources such as rangers, park fliers, the internet, or even just asking an experience friend for advice can help stop issues before they arise.

I am aware of safety resources available to me… (Question C8)

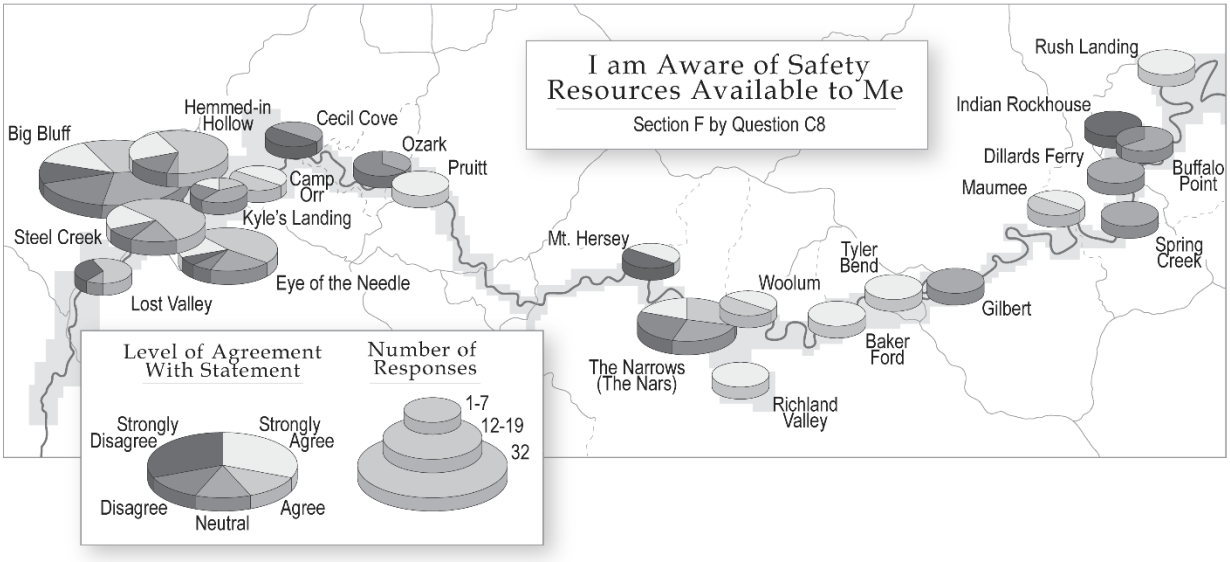


Figure 5.46: Map representing participants' agreeance with the statement "I am aware of safety resources available to me" compared to their perception of risk in the Buffalo National River.

5-6 – Comparative Mapping

Information recorded by the National Park Service on each search and rescue mission is sparse, at best. Records exist, but most of the information is largely anecdotal, resulting in difficult to use data. Regardless of these limitations, this study was able to extract solid data on the date, time, terrain, and location of SAR events, as well as in some cases the age and sex of the person involved. It is possible to compare age, sex, and location of actual search and rescue events with the perception of risk data gathered by questionnaire for this thesis.

Location of Search and Rescue Events vs. Perceived Areas of Risk According to Survey Participants

First and foremost, as a geographic study this thesis strove to answer the question "do visitors to the Buffalo National River understand where areas of risk are located within the

park?” On the following pages are simple dot density maps that represent both the perceived areas of risk (*Figure 5.47*) and the actual locations of a search and rescue event (*Figure 5.48*). Following that are two maps, one of which depicts the number of times an areas was marked as risky on the questionnaire (*Figure 5.49*) and another which depicts the number of times an area was the location of an actual search and rescue event (Figure 5.50).

It seems that participants did not have a fully comprehensive knowledge of all actual areas of risk within the Buffalo. The distribution of the areas of perceived risk is similar when compared visually to that of the actual locations of SARs, but actual locations of search and rescue events are much more numerous. This is possibly due to the fact that survey participants tended to mark only areas which were labeled on the questionnaire map.

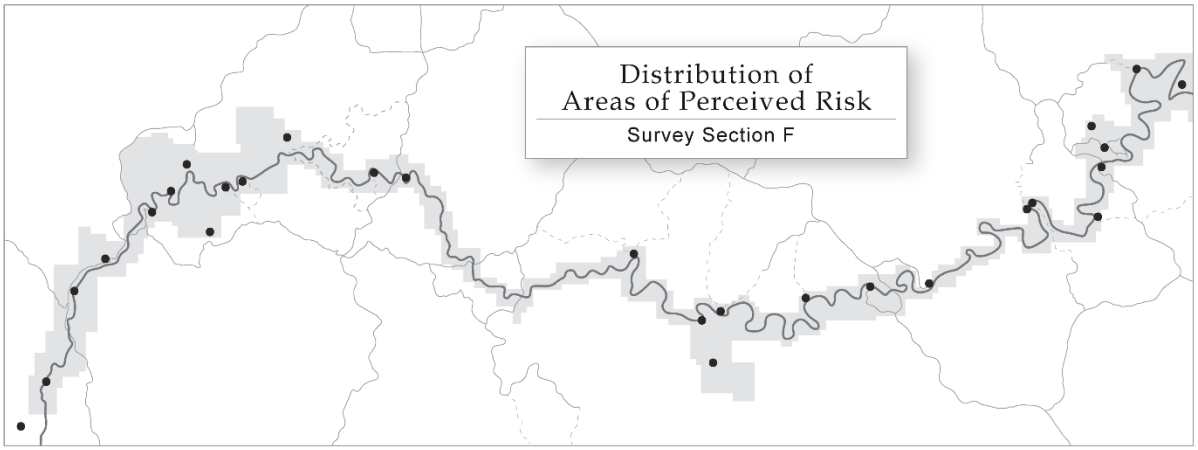


Figure 5.47: Map of the spatial distribution of areas chosen on the questionnaire map (Section F) by survey participants.

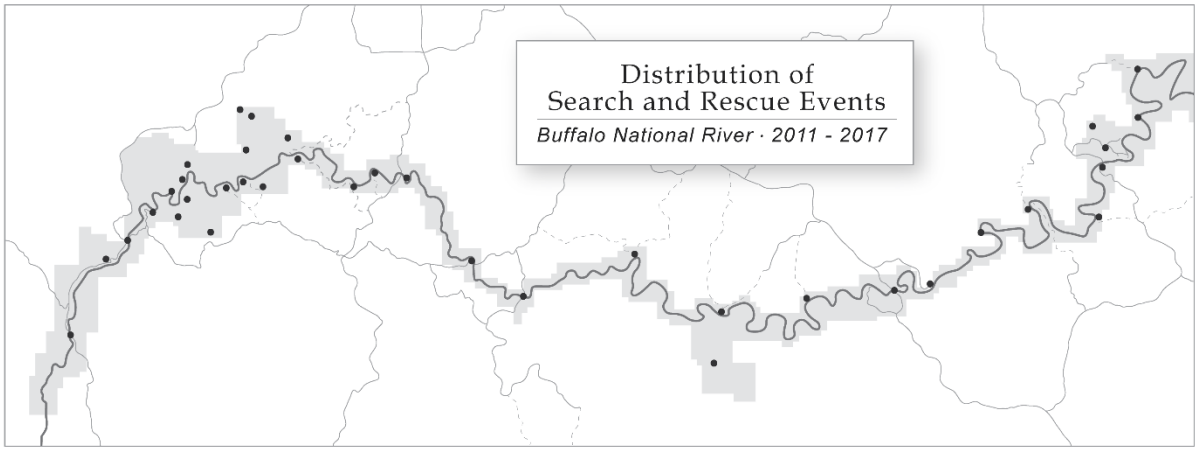


Figure 5.48: Map representing the locations of actual search and rescue events within the Buffalo National River park boundaries.

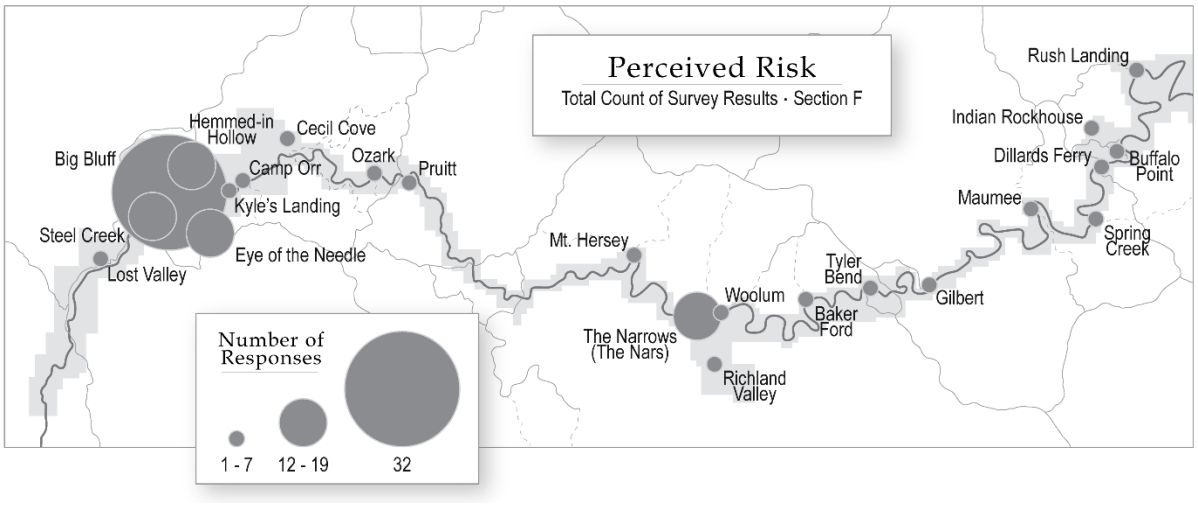


Figure 5.49: Map representing the number of times a location within the Buffalo National River was marked as an area of risk by survey participants.

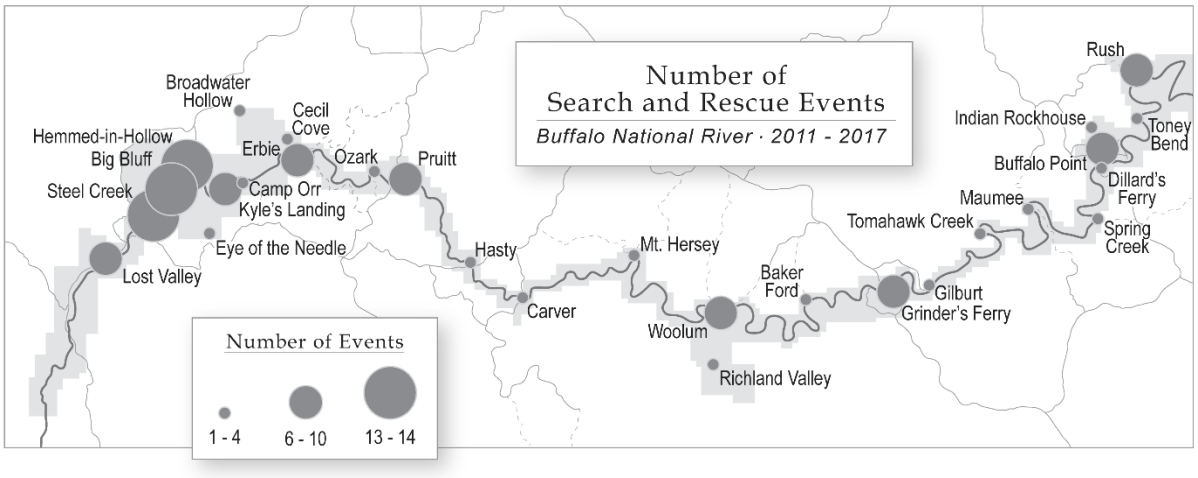


Figure 5.50: Map representing the number of times an area was the location of a search and rescue emergency event.

As shown in *Figure 5.49*, many participants perceived the Upper Buffalo to be a risky area. 40% of participants marked Big Bluffs as an area of elevated risk, and they were correct. The popular scenic area Big Bluffs, off of the Centerpoint Trail, was home to 14 search and rescue events from the years 2011 to 2017. Its excellent views make Big Bluffs a desired destination, but at over 6 miles roundtrip and with an elevation change of 1,300ft, getting there is a strenuous day of hiking (“Upper District Hiking,” 2019).

Many survey participants anecdotally mentioned a fear of falling from Big Bluffs' high ledges. Though some of the search and rescue events located at Big Bluffs were for fall victims, plenty of emergency calls were because the victim was lost, caught after dark, or had overexerted themselves on the strenuous trail.

Figure 5.51: A view of hikers on the Goat Trail at Big Bluffs (Personal Photo).

Between 12 and 19 participants marked Steel Creek, Hemmed-in-Hollow, Eye of the Needle, and the Narrows as dangerous areas. When looking at the graduated circle maps above, one can see that the perceptions of risk at Steel Creek and Hemmed in Hollow are similar to the actual SAR event counts that have taken place there. However, there is a

discrepancy between the perceived and actual risk at Eye of the Needle and the Narrows. Many survey participants mentioned that both names sounded “scarier” than the surrounding areas. These participants might not have been very familiar with the area and were making their decision based on name alone. Meaning, some participants indicated that they perceived Eye of the Needle and the Narrows to be risky simply because they perceived the names to be scary. In actuality, only two SAR events have taken place at Eye of the Needle and none have occurred at the Narrows.

Figure 5.52: Image of “The Nars,” a limestone ridge towering over the Buffalo River near Woolum (“Middle District Floating,” 2018).

Sex of Search and Rescue Victims vs. Sex of Survey Participants

Because there were far fewer females surveyed than males (*Figure 5.3*), the sectored coins in *Figure 5.53* below are dominated by the lighter gray color that represents male survey

participants. Though more males participated in the survey, more females were actually the subject of search and rescue events (*Figure 5.54*). Over half of the search and rescue events that took place at Steel Creek (57%), Big Bluffs (60%), and Hemmed-in-Hollow (62%) involved a female.

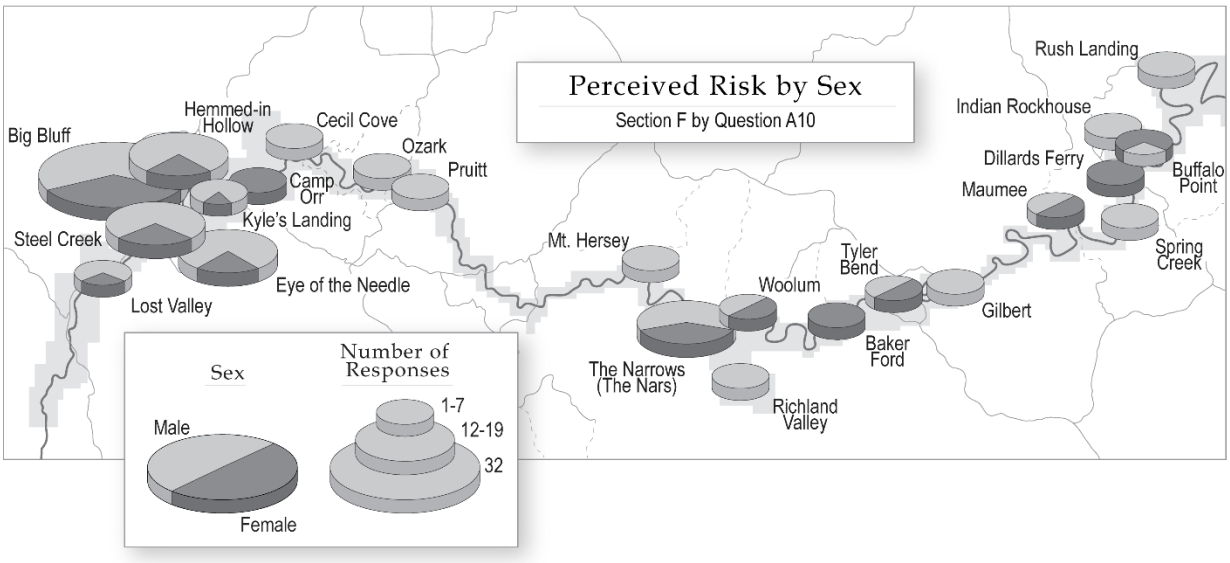


Figure 5.53: Map depicting the perceived risk of areas in the Buffalo National River mapped by the recorded sex of the survey participant.

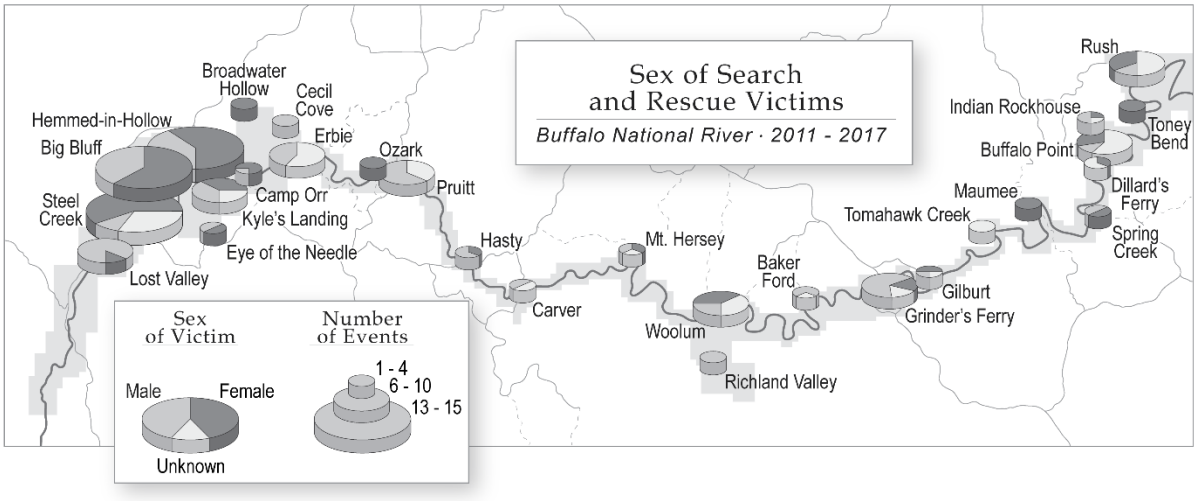


Figure 5.54: Map representing the sex of search and rescue victims and the areas in which the search and rescue event occurred.

Age of Search and Rescue Victims vs. Age of Survey Participants

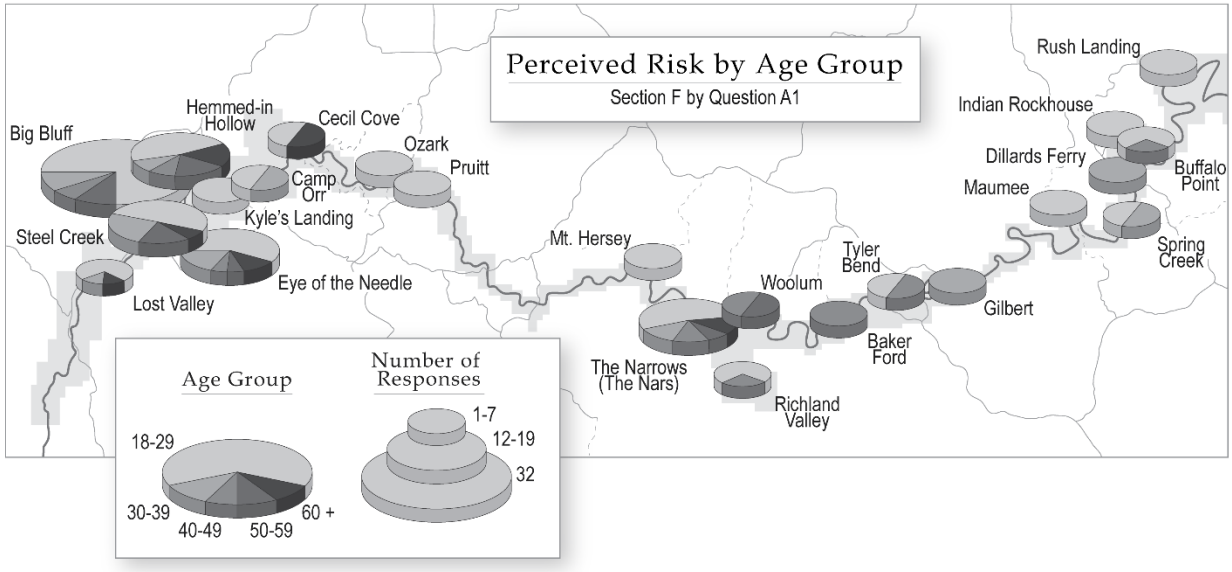


Figure 5.55: Map depicting how a participant's age group compares to their perceived risk in the Buffalo National River.

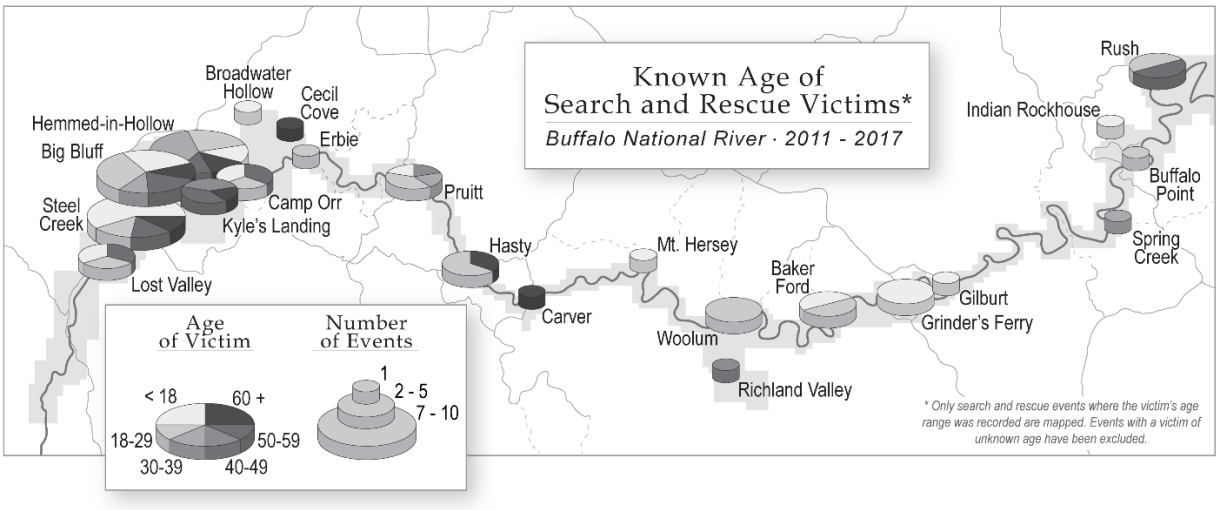


Figure 5.56: Map representing a person's age at the time that they were the subject of a search and rescue event.

As evident in *Figure 5.*2, a large number (51%) of participants fell into the 18 – 29 age range. Because of this, the map comparing A1 to Section F (*Figure 5.55*) is largely dominated

by the palest gray, which represents the 18 – 29 age group. Regardless, the map reveals that few participants ages 50 or older believe that there is risk present in the Lower Buffalo and, interestingly, *Figure 5.56* representing the actual search and rescue events in the Buffalo River corroborates that theory. A large percentage of participants 60+ believe that risk is present at Hemmed-in-Hollow (16%), but the SAR events involving people aged 60 and up were more evenly dispersed among locations in the Upper Buffalo than the perception data suggests. As previously mentioned, the hike to Big Bluffs is a strenuous hike. 7% of SARs occurring at Big Bluffs involved people aged 60+. Despite this, no survey participants aged 60+ marked Big Bluffs as dangerous.

5-7 – Fatalities in the Buffalo National River

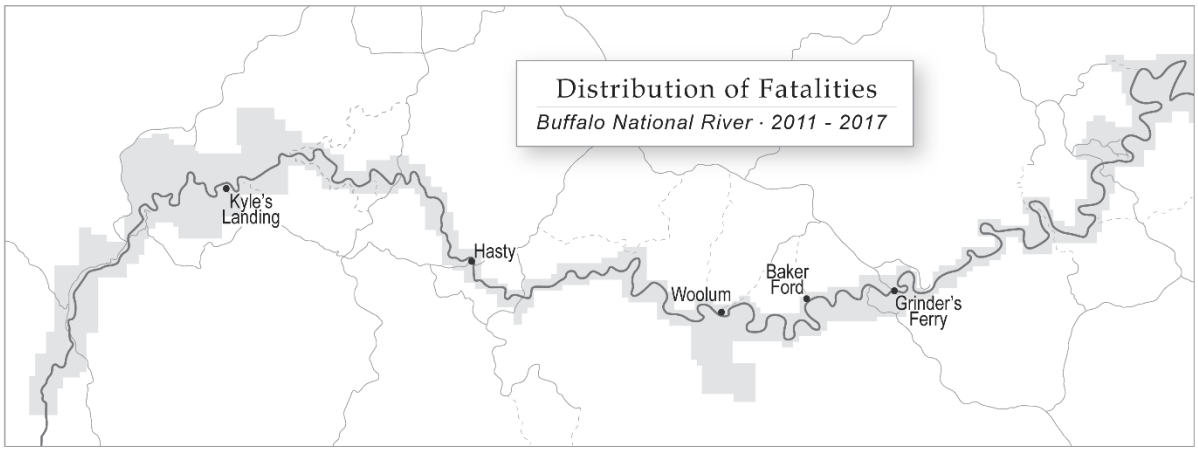


Figure 5.57: Map showing the distribution of recorded fatalities in the Buffalo National River, 2011-2017.

Making a mistake or a bad decision in any area can result in death, and the Buffalo River is no exception. Between 2011 and 2017, five fatalities occurred within park boundaries. Of these, one of the deceased fell into the 18-29 age group and another fell into the 50-59 age group. The age of one of the deceased was less than 18, and two were of unknown age. All of

the known causes of fatalities were a result of high-water levels, and victims were killed either while swimming or canoeing. All of the victims were male.

Chapter Six: Conclusions, Implications, and Suggestions

Even encompassing 135 miles of river and over 94,000 acres of land, America's first National River is still on the smaller side when compared to other National Parks. This does not mean that the Buffalo River is any less risky. The Buffalo is a rugged stretch of land, beautiful in its wildness. Tall bluffs, collapsed caves, tricky currents, and potentially harsh weather await the unprepared adventurer. The National Park Service strives to protect both the land and the visitors to it, making a study of risk perception in the Buffalo National River absolutely imperative.

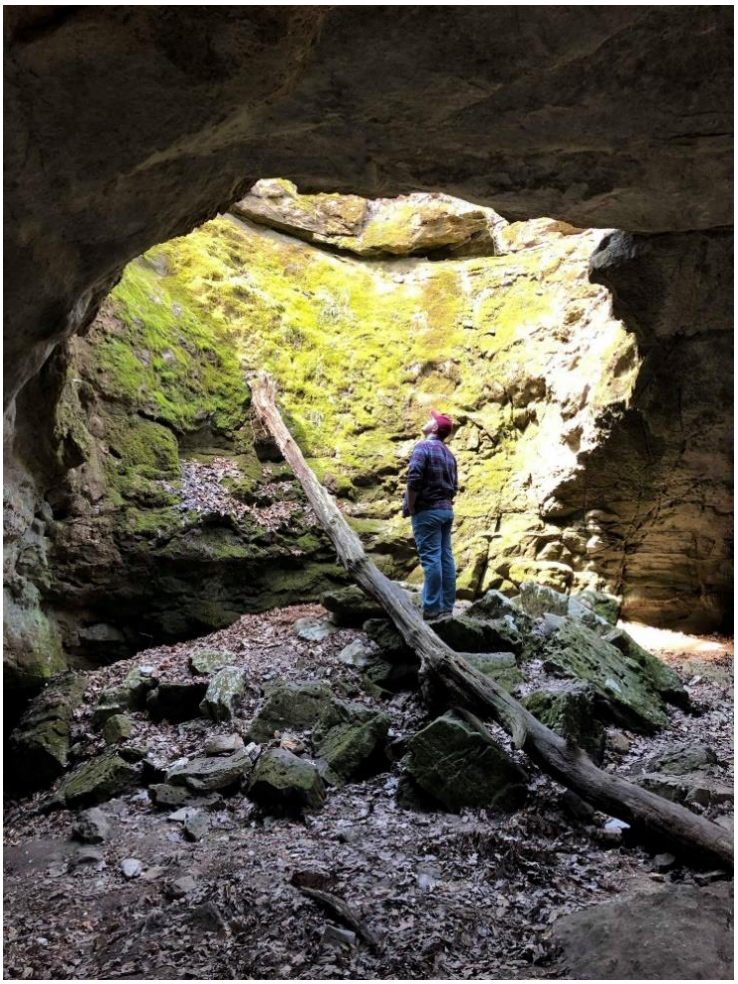


Figure 6.1: Hiker Dan Smith gazes in awe at a skylight in a shelter cave near the Indian Rockhouse on the Lower Buffalo River (Personal photo).

National Park Service rangers have a duty to protect both visitors and park resources – a job that is difficult to do without understanding visitors' perception of risk (Ken Smith, 2018, p. 124). The importance of studying risk perception was realized in the early 1960s with Gilbert F. White's flood zone studies and work on the topic was continued and refined by Slovic, Fischhoff, and Lichtenstein in the 1970s (White, 1964; Cutter, 1994, p. 155). Since then, risk perception studies have been performed on a number of topics, but few have been utilized to assess risk in National Parks. No prior risk perception studies were done involving the Buffalo National River.

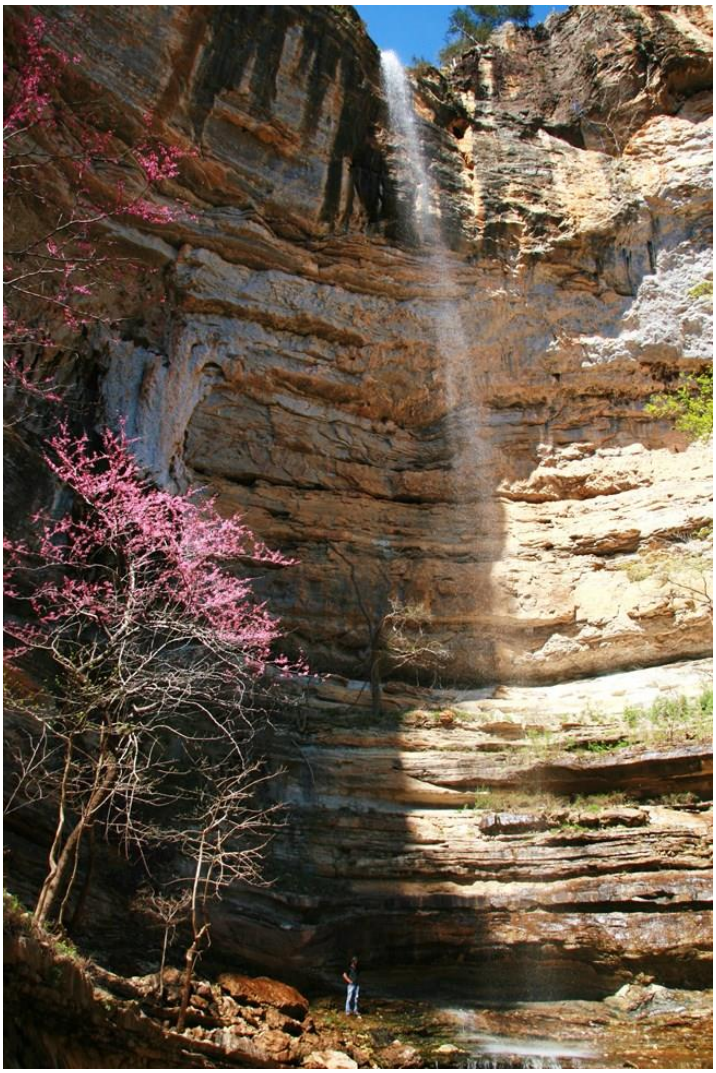


Figure 6.2: A hiker stands below Hemmed-in-Hollow in the springtime when the waterfall's flow is the fastest ("Hemmed in Hollow in Spring," NPS).

This study gathered data on search and rescue events within the park between 2011 and 2017, as well as survey data that endeavored to shed light on how visitors perceive risk in the Buffalo. Following the data collection, a combination of R calculations and Microsoft Excel pivot tables were used to analyze the data. The data were then mapped using a variety of different strategies in an attempt to expose how accurate visitors' perceptions of risk in the Buffalo truly were.

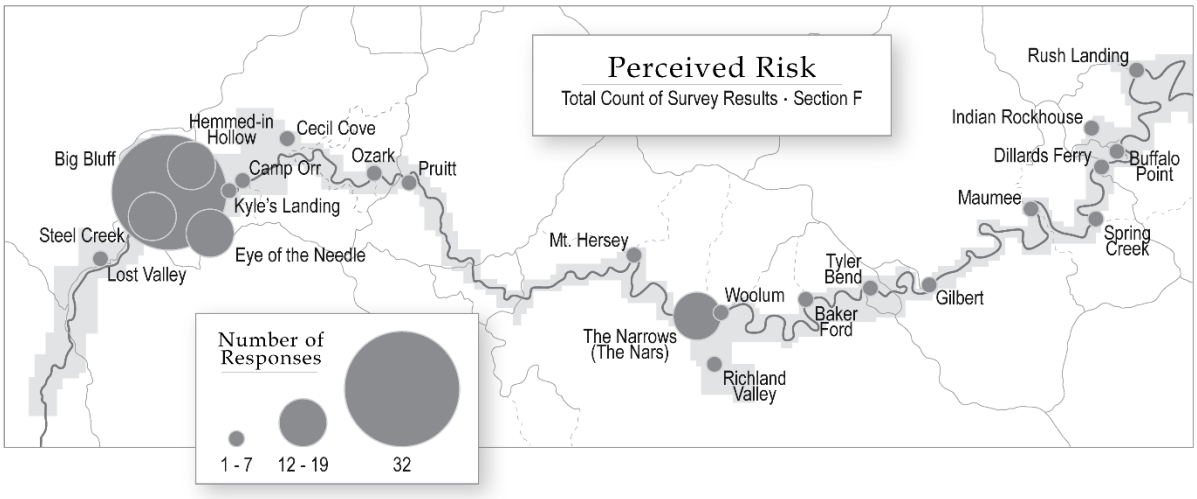


Figure 6.3: Map representing the number of times a location within the Buffalo National River was marked as an area of risk by survey participants.

Data analysis revealed a number of spatial and statistical trends. Overall, the visitors who were surveyed had a generally good grasp of which areas have the potential for higher risk. Forty percent of survey participants marked Big Bluffs as an area of risk, making it the most chosen area on the survey map. Big Bluffs was also the location with the highest number of search and rescue events between 2011 and 2017, according to the data gathered from the NPS. While visitors may understand that risk is present in the Big Bluffs area, park rangers may still need to bolster their education efforts for that location to minimize the occurrence of search and rescue calls.

Figure 6.4: The author standing on the trail at Big Bluffs with a view of the river valley behind her. Viewers can get an idea of how close the trail is to the steep bluff drop-off. (Personal photo.)

When compared with the NPS search and rescue data, it was found that survey participants aged 50-59 or 60+ only partially understand where areas of risk are for their age group. On the survey, no participants aged 60+ marked Big Bluffs as an area of risk, but 10% of all SAR events at Big Bluffs involved people aged 60+ (*Figure 5.55 & 5.56*). Participants aged 50-59 indicated they believed that in addition to areas in the Upper Buffalo, a number of areas in the Middle and Lower Buffalo were dangerous to their age group (*Figure 5.55*). Though areas in the Middle and Lower Buffalo are not without their risks, the majority of SAR incidents involving people aged 50-59 occurred in the Upper Buffalo. Buffalo National River rangers may wish to

consider this information and plan accordingly when creating education strategies for park visitors.

A series of Likert scaled questions included on the survey gauged participants' agreement with statements on topics ranging from emergency preparedness to cell phone service. Overall, the majority of participants indicated that they always follow warning signs. That seems great, but on another question asking their agreeance with the statement "I always wear my lifejacket in/on the river," the majority of participants indicated that they did not always wear their lifejacket. There are many signs throughout the Buffalo National River warning visitors to wear their lifejackets. It seems that many do not comply, so rangers and other park personnel may wish to consider posting someone at launch points on key dates to try to warn and educated visitors verbally.

Figure 6.5: Photo of a warning sign in the Buffalo National River near Ponca, Arkansas (Personal photo).

Any death is one death too many, and the rangers and emergency personnel responding to a search and rescue call do their absolute best to prevent any further harm from befalling the person involved. Rangers also work every day at the constant task of informing the public of preventative techniques to avoid being involved in a search and rescue event. Because of their hard work and dedication, between 2011 and 2017 there were only five deaths within the Buffalo National River park boundaries. All of these deaths occurred on the water; there were no fatalities on a hiking trail or other points of interest on land. Despite this, the questionnaire results indicate that survey participants think the riskiest areas of the park are on land. The majority of participants chose Big Bluffs, Hemmed-in-Hollow, Steel Creek, Eye of the Needle, and The Narrows as areas of elevated risk. Only two of those – Steel Creek and The Narrows – are points of interest on the river.

The park service does an excellent job of giving visitors basic safety instructions on their website, social media, and in person. However, rangers should consider emphasizing educational efforts on the more specific, potentially fatal dangers the Buffalo River holds. It is possible that news coverage of fatalities at nearby Hawksbill Crag (also known as Whitaker Point) overpower the Buffalo River personnel's education efforts. Survey participants may have been more informed on fatal falls from Hawksbill Crag than on drownings in the Buffalo River, potentially explaining the surveyed population's opinion that Big Bluffs, an area with steep bluffs similar to Hawksbill, was an area of high risk.

Figure 6.6: Visitor Keith Terhune takes in the view while safely sitting atop Hawksbill Crag (Personal photo).

This study was limited by temporal and financial restrictions. The author was forced to gather data on only four days. Had there been more time or better funding to utilize research assistants, more visitors could potentially have been surveyed resulting in an even more thorough study. In addition, the data gathered from the questionnaire included far more information than the author was able to analyze in the necessary time period. Future studies should consider the following suggestions:

- Gather even more completed surveys from visitors.
- Explore the impact of which activity visitors usually participate in on their perception of risk.

- Create a more comprehensive survey to allow the researcher to weight participants' perceptions of the severity of risk in different areas of the park
- Survey park rangers, SAR volunteers, and other emergency responders and compare their perception of risk with that of the general public.

The National Park Service at the Buffalo National River should also consider standardizing its SAR data collection process. As of right now, responders to the SAR event have a very anecdotal method of recording data. The NPS should try to further regulate what data is reported and make sure that the entire form is filled out. More comprehensive data could lead to better analysis and better risk prevention strategies for the park to use. It is recommended to always record data on the sex, age, activity which led to the SAR, and what type of accident occurred, as well as recording the precise coordinates of where the accident took place. Spatial data is especially important to record as it tells much more than regular data on its own, so the park service needs to do their best to track where SARs occur. In this way they will be able to strategize the best way to educate visitors and prevent search and rescue missions from ever needing to take place.

Prior to this study, no other known assessments of risk perception had been done on the Buffalo National River. Because of this, this study can be thought of as a replicable template that should be followed by other similar research projects, be it further research in the Buffalo National River or other recreation areas, state or national. This baseline study has revealed important information on risk perception in the Buffalo National River. Generally, visitors are well informed about where areas of higher potential risk are. Of those surveyed, people aged 60+ did not believe that Big Bluffs was a risky zone, though 10% of SARs in the area involved people of their age group. The majority of participants indicated that they always followed warning signs, but many said they did not always wear their lifejacket on the river, directly going against plenty of signs. Visitors to the Buffalo River may not be as aware of dangers on the river

as they are of dangers posed by tall bluffs. These revelations, along with other helpful information discovered in this study, can help National Park Service personnel better educate the public on risk within the Buffalo National River, potentially reducing the number of search and rescue events within the park.

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Appendix A: Survey Instruments and Approvals

UNIVERSITY OF ARKANSAS

To:	Julie Nicole Terhune
From:	Douglas James Adams, Chair IRB Committee
Date:	12/13/2018
Action:	**Exemption Granted**
Action Date:	12/13/2018
Protocol #:	1811161944
Study Title:	Geospatial Analysis of Safety and Risk Perception in the Buffalo National River

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Thomas R Paradise, Investigator

Appendix A1: University of Arkansas IRB approval letter

APPLICATION FOR A SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior

National Park Service

All or some of the information you provide may become available to the public.

OMB # 1024-0236
Exp. Date 07/31/2020
Form No. 10-741a

Name of the National Park Service area you are applying to: Buffalo

Type of application:	**Please enter numbers for permit renewal or modification requests:**
New application	**Previously assigned NPS study number:**
	Previously assigned NPS permit number:

Contact information for the current principal investigator

Principal investigator: Julie Terhune	**Office phone:** 8706127525
Mailing address of principal investigator: 864 W Melmar Drive, Fayetteville, AR 72703, United States	**Alternative phone:**
	Office fax:
Name of the current institution represented University of Arkansas-Fayetteville	**Office email address:** jnterhun@email.uark.edu

Additional investigators or key field assistants (first name, last name, office phone, office email)

Name: Julie Terhune	**Phone:** 8706127525	**Email:** jnterhun@uark.edu
Name: Thomas Paradise	**Phone:**	**Email:** paradise@uark.edu

Scientific Study Information

Study Title (maximum 300 characters)
Geospatial Analysis of Safety and Risk Perception in the Buffalo National River

Purpose of the study (maximum 4000 characters)
The purpose of this study is to analyze risk perception in the Buffalo National River spatially and in comparison to search and rescue (SAR) historical data in order to present the Buffalo National River with information regarding how to minimize or mitigate risks.

Summary of proposed field methods and activities (extract from the study proposal where appropriate - maximum 4000 characters)
I plan to go to popular areas in the Buffalo National River area, such as hiking trails or scenic overlooks, and ask visitors if they would be willing to participate in a survey. I will make sure they understand that it is completely voluntary and anonymous. If they volunteer, visitors will then complete a short survey (one page front and back) and they will be given a small piece of paper with information regarding the researcher, how to find out results of the survey, and their anonymity. The entire survey should take no more than 5-8 minutes.

Study Schedule	**Field Schedule**
Initial starting date of the study: Feb 02, 2019	**Date to begin study within the park this application year:** Feb 02, 2019
Estimated date the entire study may end: Apr 26, 2019	**Date to end study within the park this application year:** Apr 26, 2019

Does your study propose to involve any of the following?
None selected

Activity Type:
Research

Do you anticipate receiving funding assistance from the U.S. Federal Government for this study? (Yes or No)
No

Appendix A2: National Park Service research permit, page 1.

If yes specify the agency(s):

Where will data, maps, photos, etc. (not specimens) reside upon completion of this study?
They will reside at my institution, the University of Arkansas, in Fayetteville, Arkansas.

Location(s) where you propose activities will take place within the National Park System area(s):
Hawksbill (though not expressly in the BNR), Boxley, Lost Valley (if open in time), Ponca, Steel Creek, Hemmed-in-Hollow, Centerpoint Trail/Big Bluffs, Kyle's Landing, Camp Orr, Cecil Cove, Erbie, Ozark, Pruitt, Hasty, Carver, Mt. Hersey, Woolum, Richland Valley, Baker Ford, Tyler Bend, Grinders Ferry, Gilbert, Maumee (North and South), Spring Creek, Dillards Ferry, Buffalo Point, Indian Rockhouse, Rush Landing

Your proposed method of access (vehicles, aircraft, boat, snowmobile, foot, etc.):
I will drive to locations where possible, and potentially hike to locations as well.

Paperwork Reduction Act Statement: A federal agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. Public reporting for this collection of information form is estimated to average 1.38 hours per response, including the time for reviewing instructions, gathering and maintaining data, and completing and reviewing the forms. Direct comments regarding this burden estimate or any aspect of this form to Dr. John G. Dennis, Natural Resources (3130 MIB), National Park Service, 1849 C Street, N.W., Washington, DC 20240.
Privacy Act Notice: Scientific research, education and collecting activities within units of the National Park System that may impact parks invoke a permitting and reporting requirement per regulations at 36 CFR 1.6 (Permits), 36 CFR 2.1 (Preservation of Natural, Cultural and Archeological Resources), and 36 CFR 2.5 (Research Specimens). The National Park Service collects information about permit applicants and permittees to administer and document research, collecting, and reporting activities within parks. The information disclosed on this form is required and may result in denial of permit applications if not provided.

Appendix A2: National Park Service research permit, page 2.

UNIVERSITY OF ARKANSAS

BUFFALO NATIONAL RIVER

Risk Assessment Survey

UNIVERSITY OF ARKANSAS GEOSCIENCES

AGE: ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 or older

HOMETOWN: _____ (City, State) ☐ Urban ☐ Suburban ☐ Rural

Number of Years: _____

CURRENT PLACE OF RESIDENCE: _____ (City, State) ☐ Urban ☐ Suburban ☐ Rural

Number of Years: _____

EDUCATION: ☐ High school ☐ Some college ☐ 2yr college ☐ 4yr college ☐ Advanced degree

INCOME: ☐ <$25,000 ☐ $25,000-$49,999 ☐ $50,000-$74,999 ☐ $75,000-$100,000 ☐ >$100,000

SEX: ☐ Male ☐ Female Do you smoke or vape? ☐ Yes ☐ No

How many times per year do you visit the Buffalo National River (BNR)? _____

Approximately how many years have you been visiting the BNR? _____

What activity/activities do you participate in?

☐ Kayaking/Canoeing ☐ Tubing ☐ Swimming ☐ Day hiking ☐ Overnight hiking

☐ Car camping ☐ Recreation area use ☐ Horseback riding ☐ _____

How many years have you done said activity/activities? _____

I would say that my skill level is… ☐ Beginner ☐ Intermediate ☐ Expert

Statement…	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
I always research before doing one of the activities listed.					
I always wear my life jacket in/on the river.					
I always follow warning signs.					
The information presented by the National Park Service is useful.					
I have a plan in case of injury.					
I have a plan for personal evacuation.					
I am concerned about cell phone service.					
I am aware of safety resources available to me.					

Please list all safety resources that you are aware of:

_____

_____

Appendix A3: Research instrument, page 1.

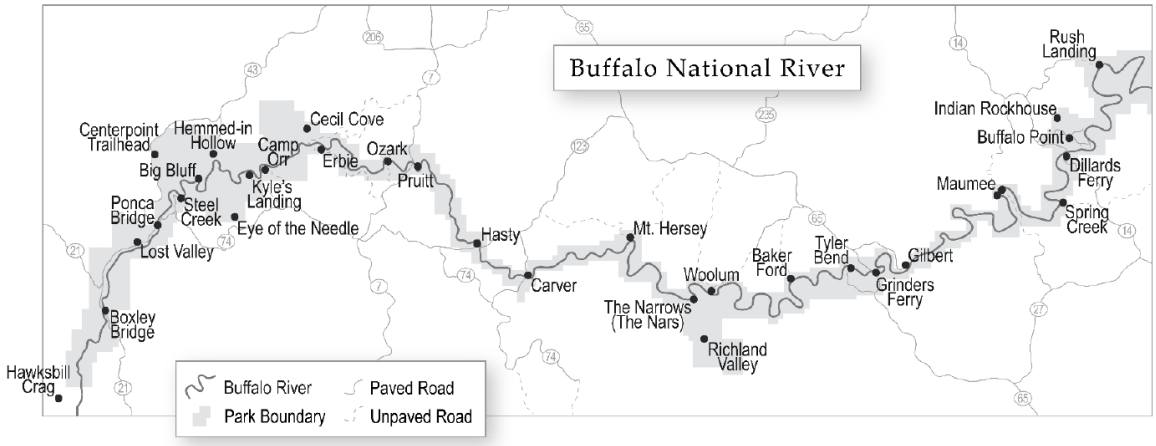
Which activity do you think is the MOST dangerous? Rank from 1-8, with 1 being the MOST dangerous and 8 being the LEAST dangerous.

___ Kayaking/Canoeing
___ Swimming
___ Overnight hiking
___ Recreation area use
___ Tubing
___ Day hiking
___ Car Camping
___ Horseback riding

What do you think poses the greatest risk to your safety? Rank from 1-12, with 1 being the MOST risky and 12 being the LEAST risky.

___Dehydration
___Weather
___Venturing into caves/mines
___Wildlife - mammal (bears, elk)
___Flipped boat
___Getting caught after dark
___Cliff jumping into river
___Wildlife – non-mammal (snakes, bugs)
___Consuming alcohol in excess
___Heights
___High water levels
___Fire

Please mark an 'X' on the area or areas you think are the most dangerous. Please do not mark more than 5 locations.



Comments:

_____
_____
_____
_____
_____
_____

Thanks!

Appendix A3: Research instrument, page 2.

UNIVERSITY OF ARKANSAS

BUFFALO NATIONAL RIVER

Risk Assessment Survey

UNIVERSITY OF ARKANSAS GEOSCIENCES

A

1 AGE: ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 or older

2 HOMETOWN: _____(string)_____ (City, State) 3 ☐ Urban ☐ Suburban ☐ Rural

4 Number of Years: _____(numeric)_____

5 CURRENT PLACE OF RESIDENCE: _____(string)_____ (City, State) 6 ☐ Urban ☐ Suburban ☐ Rural

7 Number of Years: _____(numeric)_____

8 EDUCATION: ☐ High school ☐ Some college ☐ 2yr college ☐ 4yr college ☐ Advanced degree

9 INCOME: ☐ <$25,000 ☐ $25,000-$49,999 ☐ $50,000-$74,999 ☐ $75,000-$100,000 ☐ >$100,000

10 SEX: ☐ Male ☐ Female 11 Do you smoke or vape? ☐ Yes ☐ No

B

1 How many times per year do you visit the Buffalo National River (BNR)? _____(numeric)_____

2 Approximately how many years have you been visiting the BNR? _____(numeric)_____

3 What activity/activities do you participate in?

Binomial: 1 = yes 0 = no

a ☐ Kayaking/Canoeing b ☐ Tubing c ☐ Swimming d ☐ Day hiking e ☐ Overnight hiking

f ☐ Car camping g ☐ Recreation area use h ☐ Horseback riding ☐ i = other(Y/N) _____ j = value of other _____

4 How many years have you done said activity/activities? _____(numeric)_____

5 I would say that my skill level is… ☐ Beginner ☐ Intermediate ☐ Expert

C

	Statement…	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I always research before doing one of the activities listed.	1	2	3	4	5
2	I always wear my life jacket in/on the river.	↓	↓	↓	↓	↓
3	I always follow warning signs.	↓	↓	↓	↓	↓
4	The information presented by the National Park Service is useful.	↓	↓	↓	↓	↓
5	I have a plan in case of injury.	↓	↓	↓	↓	↓
6	I have a plan for personal evacuation.	↓	↓	↓	↓	↓
7	I am concerned about cell phone service.	↓	↓	↓	↓	↓
8	I am aware of safety resources available to me.	↓	↓	↓	↓	↓

9 Please list all safety resources that you are aware of: _____(string)_____

_____

_____

Appendix A4: Research instrument (page 1) with section and question codes used for data entry and analysis.

For Sections D and E, record the ranking level given, but 0 = no answer

D Which activity do you think is the MOST dangerous? Rank from 1-8, with 1 being the MOST dangerous and 8 being the LEAST dangerous.

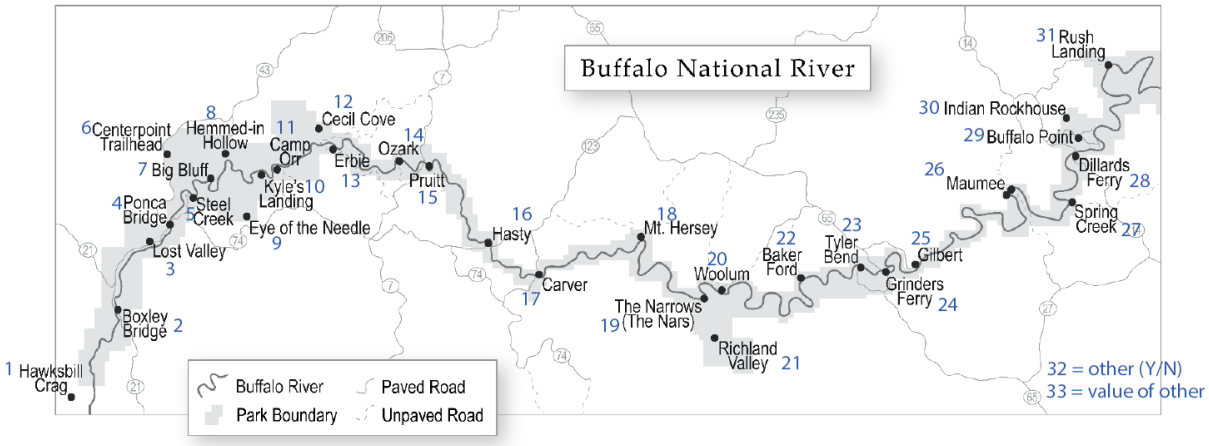
1 Kayaking/Canoeing	5 Tubing
2 Swimming	6 Day hiking
3 Overnight hiking	7 Car Camping
4 Recreation area use	8 Horseback riding

E What do you think poses the greatest risk to your safety? Rank from 1-12, with 1 being the MOST risky and 12 being the LEAST risky.

1 Dehydration	5 Flipped boat	9 Consuming alcohol in excess
2 Weather	6 Getting caught after dark	10 Heights
3 Venturing into caves/mines	7 Cliff jumping into river	11 High water levels
4 Wildlife - mammal (bears, elk)	8 Wildlife – non-mammal (snakes, bugs)	12 Fire

F Please mark an 'X' on the area or areas you think are the most dangerous. Please do not mark more than 5 locations.

Binomial: 1 = yes, 0 = no

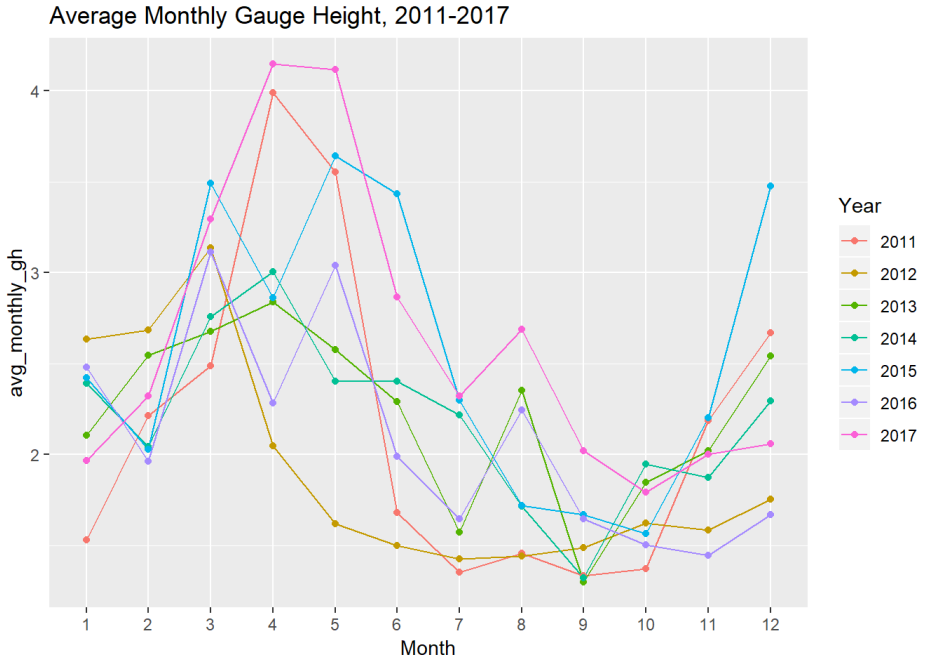


G Comments: (string)

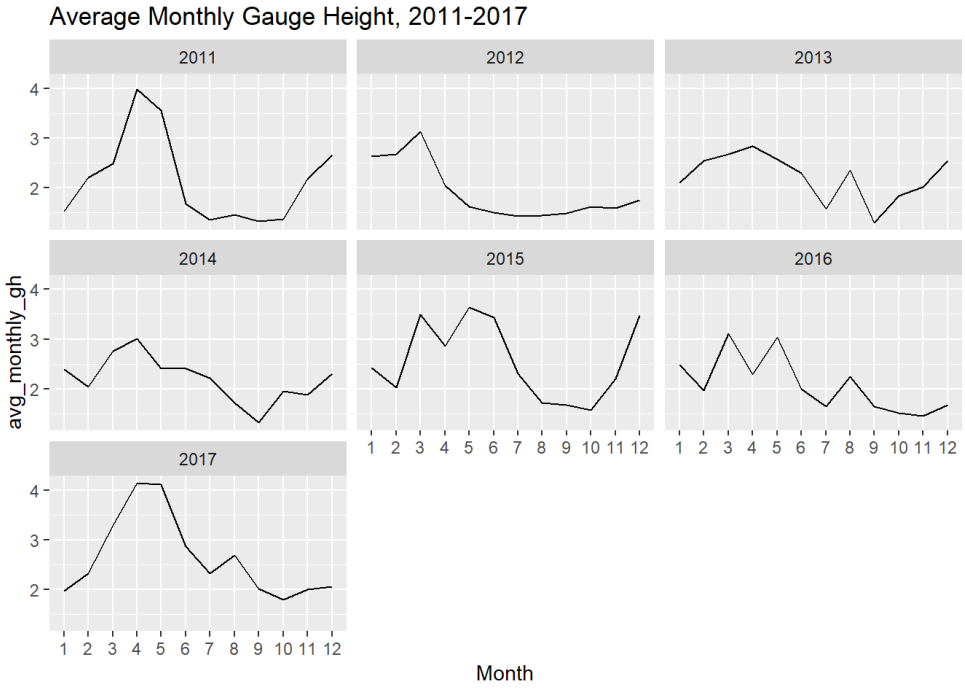
Thanks!

Appendix A4: Research instrument (page 2) with section and question codes used for data entry and analysis.

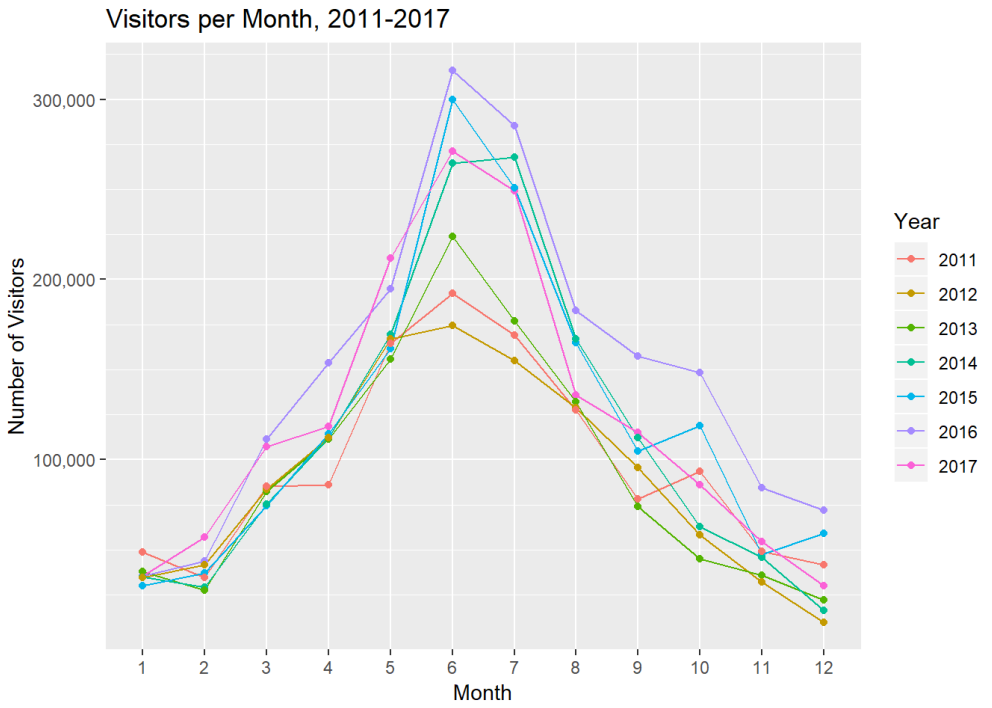
Appendix B: Further Maps, Graphs, and Images



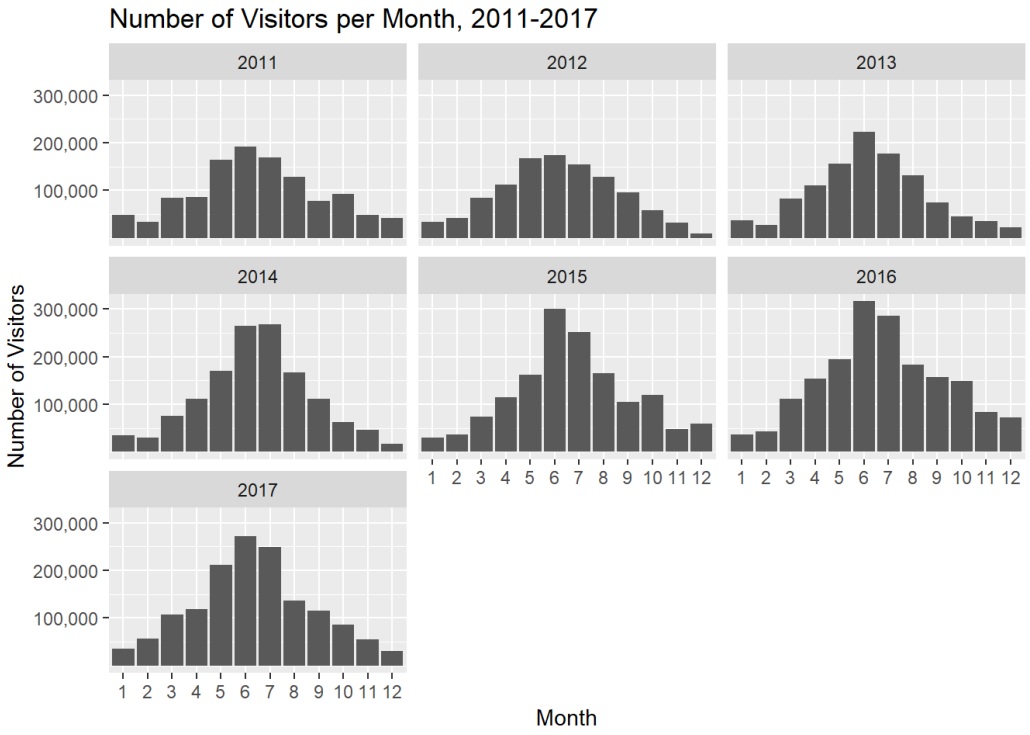
Appendix B1: Average monthly gauge heights of a river level gauge near Ponca, Arkansas from the years 2011 to 2017. Created in RStudio.



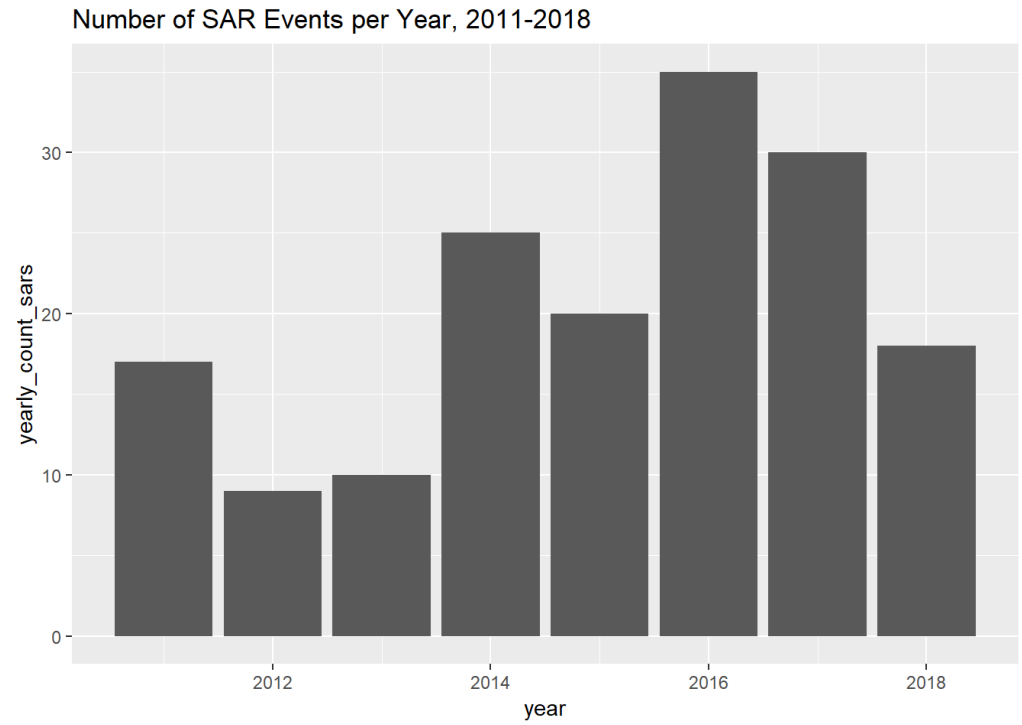
Appendix B2: Average monthly gauge heights of a river level gauge near Ponca, Arkansas, broken down by year (2011 – 2017). Created in RStudio.



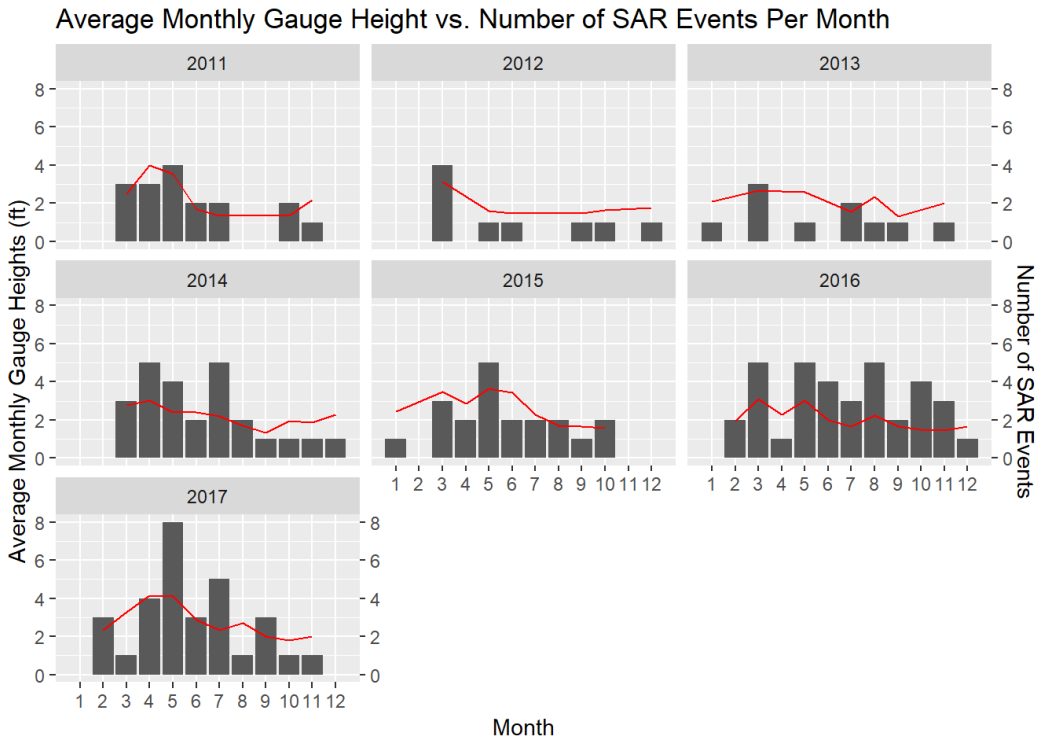
Appendix B3: Average monthly visitor count estimate for the Buffalo National River, 2011 – 2017. Created in RStudio.



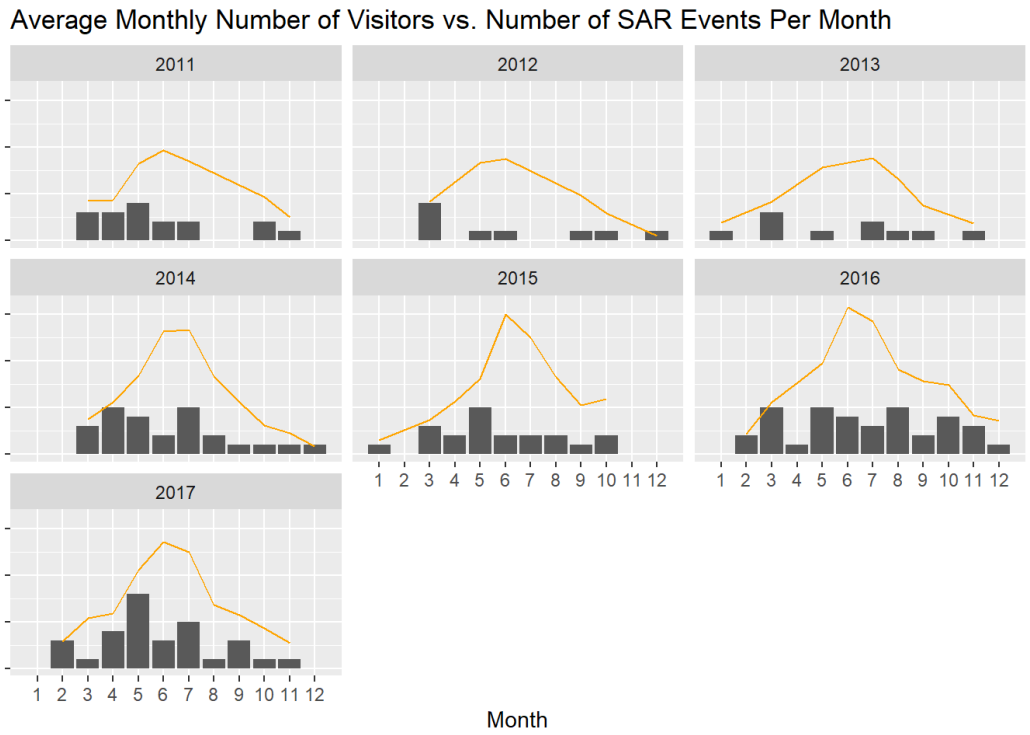
Appendix B4: Average monthly visitor count estimate for the Buffalo National River (2011-2017) broken down by year. Created in RStudio.



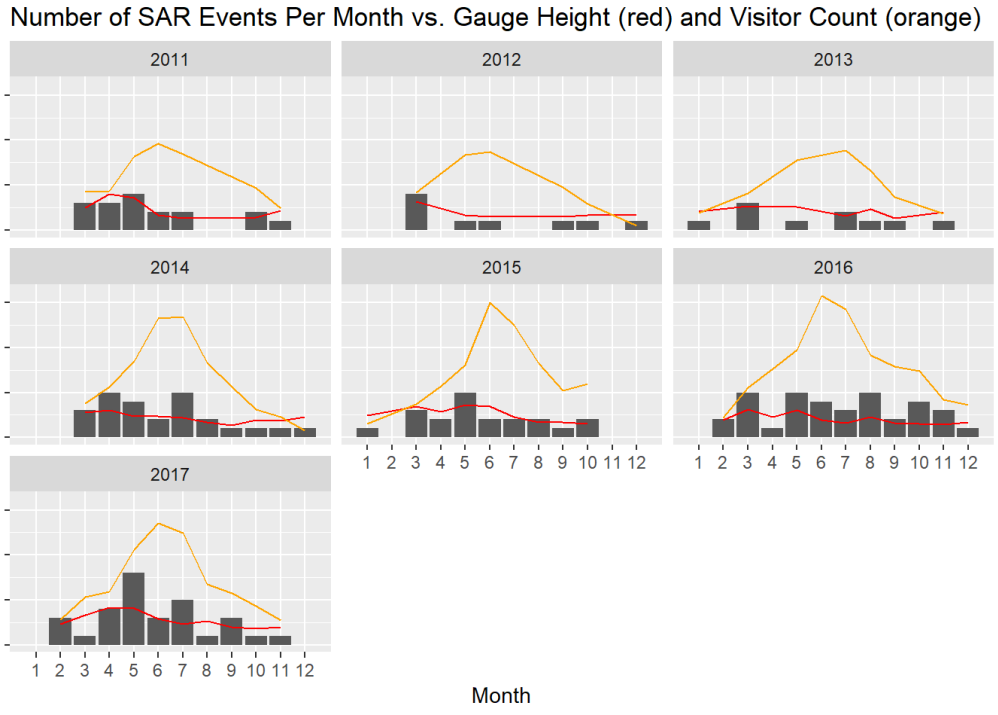
Appendix B5: Total number of search and rescue (SAR) events per year, 2011-2018.



Appendix B6: Number of monthly SAR events (bar graph) compared to average monthly gauge height (red line graph), 2011 – 2017.



Appendix B7: Number of monthly SAR events (bar graph) compared to average monthly visitor count (orange line), 2011 – 2017.



Appendix B8: Number of monthly SAR events (bar graph) compared to average monthly gauge height (red line) and average visitor count (orange line), 2011 – 2017.