Recreational Risk Assessment using Geospatial Analyses on Beaver Lake, Arkansas

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Recreational Risk Assessment using Geospatial Analyses on Beaver Lake, Arkansas
Recreational Risk Assessment using Geospatial Analyses on Beaver Lake, Arkansas

A Thesis Submitted in partial fulfillment of the requirements for the degree of a Master of Arts in Geography

By:

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December 2014
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This Thesis is approved for recommendation to the Graduate Council.

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ABSTRACT

Accidents and deaths occur regularly on lakes and waterways due to natural phenomena as well as human error and recreation. People use lakes and waterways as sources of recreation, but do not always act responsibly on the water. During summer 2013 and winter 2014, over 100 surveys were administered in Beaver Lake, Arkansas to local and federal agencies regarding their knowledge and perception on accident locations and causes. These surveys were conducted in English and approved by the university after being tested on peers. The surveys included demographic data sex, income, education, as well as Likert-scaled responses. Research was also conducted using online newspaper resources and data provided by the Little Rock, Arkansas Game & Fish Board on accident locations and causes. The surveys were compiled and analyzed spatially and graphically to compare the perceptions provided by the respondents to actual accident records.

Agency Reports divulged that men were most often the operators of the boats (82%) and that the more experienced boaters were more likely to be involved in an accident; this information differed from the perception surveys. Most of the people surveyed viewed men as less culpable (44%) or were noncommittal in their responses (39%) in comparison to the records that show men were responsible for 82% of the accidents. Men were also the majority of deaths in 2013 (83%). Lastly, the outcome of this study showed that most agencies were familiar with the areas they were closest to but disregarded other portions of the lake even though they were all included in the jurisdiction. The majority of agency employees believe that policies should be enforced on the lake and that the water safety was excellent despite actual records.

Key Words: Beaver Lake, risk perception, boating accidents
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CHAPTER 1

INTRODUCTION

In the summer of 2013 there were six deaths on Beaver Lake from June through August. Four of the deaths were from drowning, 67%, and five of the six deaths were men, 83%, (NWA Media, 2014). The study results did not include injuries, or financial losses. Previously, the 2012 public Boating Accident Report from Little Rock, Arkansas Game & Fish stated that 86 accidents were reported with nine deaths, fifty-two injuries, and an estimated property damage of $328,263.00 (Arkansas Game & Fish Commission, 2012). The basis as to why these deaths and accidents occurred is the basis for this risk assessment, and is the fundamental drive behind understanding the cause behind those incidents and the discrepancies between documented facts and perception regarding hazards like this. The perception of local agencies on where and why these accidents occurred was analyzed and is presented in Chapter 5.

The number of boating accidents on waterways (lakes, reservoirs, rivers, and oceans) in the United States has fluctuated, increasing and decreasing, over the past five years. In Arkansas, it ranged from ninety-six accidents in 2009 to seventy-one accidents in 2010, but in 2012 the accidents increased to eighty-six (Game & Fish Commission, 2012). Alcohol is believed to be the prevailing cause in most of the survey cases, but the cause behind the fluctuation is undefined. The varying numbers have been attributed to a) the overall education of those involved in the accidents; b) whether boating education was higher in 2010 because of the rise in the reported accidents in 2009; c) if agencies patrolled the water more; d) whether tourism was higher or lower; e) age, sex, intoxication levels; and f) environmental factors like drought or flooding (Game & Fish Commission, 2012). The facts supporting the cause of accidents were compared to surveys conducted about those accidents and their locations as perceived by the
local government and federal agencies. Even though the reported accidents increased again in 2013, the fatality rate remained the lowest in five years.

The objective of this research was to compare the use of geospatial analysis to establish factual documentation of accidents and compare this and the perceived recreational risk on Beaver Lake, Arkansas. The hope was to understand the perception between the reality and opinion of agency officials involved with Beaver Lake recreation. The number of accidents on Beaver Lake was analyzed along with causes such as, whether there was alcohol involved, the sex of those involved, and the education level of the respondents. The data were provided by accident reports from the U.S. Army Corps of Engineers (USACE), and by the Arkansas Game & Fish Commission (AFGC). Summaries of the economic impact since the impoundment of Beaver Lake were also provided for background information on the appeal of its use (Donald, 1974). Also, the data provided from statistics and perceptions of the problem were mapped for educational and preventative purposes, in the hopes of providing a better understanding as to prevent future hazards may be avoided or prevented.

Risk perception may be crucial when analyzing hazardous behavior on Beaver Lake, in as much as it has a history of death and accidents. Safety on the lake would benefit from a risk study. Every year there are numerous accidents, and several people drown in Beaver Lake. Both state and government agencies were created on Beaver Lake to prevent accidents and death, but gaps in knowledge occurred between the agencies surveyed as to the locations of accidents. Most agencies surveyed patrol various portions of the lake, and the surveys showed that each agency favored certain portions of the lake that they patrolled. Some agencies claimed “their officers were not familiar enough to fill out surveys on Beaver Lake.” From such statements the goal of this research was to show any gaps in perception, and to provide informative statistics
that could help correct future issues and problems with hazardous behavior to improve the safety of Beaver Lake.

When gaps exist between the facts and deaths and the magnitude frequency and location of their hazards, and how they are perceived, the nature of the danger may be greater (Slovic, 2000) If policies are created based on perceptions alone and records they might be weak in maintaining the best safety standards.
CHAPTER 2
STUDY SITE

2.1 Formation of the Ozark Mountains Natural Division

A supercontinent once existed during the late Paleozoic and early Mesozoic era that formed roughly 300 million years ago and broke apart 200 million years ago. It was named Pangaea, meaning “entire” and “Mother Earth” (Briney, 2014). The collision of the continents converging together caused mountains to rise, such as Appalachian Mountains, which were formed when the North American plate collided with the European plate (Briney, 2014). A similar collision the supercontinent Gondwana created forces that uplifted the area of North Arkansas, which is comprised of limestone and calcareous rocks like dolostone, as well as sandstone and chert (State of Arkansas, 2012). Erosion is what formed the uplands and plateaus that natives of Arkansas are familiar with today. Those uplands and plateaus became known as the Boston Mountains Plateau, the Springfield Plateau, and the Salem Plateau with each underlain by a different lithology. From the plateaus, rivers cut into, or eroded, valleys into the plateaus until the only remains of the plateau are hilltops and mountains.

Figure 2.1: The different plateaus in Northern Arkansas (State of Arkansas, 2012).
The eroded plateaus in Northwestern Arkansas are the Ozark Mountains Natural Division, which includes cities such as: Fayetteville, Springdale, and Rogers in Washington and Benton counties; Harrison in Boone County; Mountain Home in Baxter County; Batesville in Independence County, and Clinton in Van Buren County (State of Arkansas, 2012). The plateau topography in these areas is extensive and provided opportunity for urban and agricultural development, which is why settlements were created there and were quickly populated (State of Arkansas, 2012). Other areas, like the Boston Mountains, were too rugged and did not offer easy access for travel or development. Those who did settle in the Boston Mountains led the mountaineer lifestyle or what is referred to as the “hillbilly” lifestyle (State of Arkansas, 2012).

Figure 2.2: Population density of Arkansas in people per square mile (Keckhaver, 2014).
The topography created fostered not only the lifestyle that emerged, but it also created the conditions necessary for certain minerals and gasses to form. Arkansas, well known as “The Natural State,” provides many natural minerals, the value of which exceeds one billion dollars in petroleum, natural gas, and bromine per year. Arkansas is also known for the only diamond mine that is open to the public in the U.S. and also as a leading producer of bauxite, which provides over eighty percent of the ore in the U.S. from which aluminum is made (Howard, 2011). The bromine produced in Arkansas accounts for one-half of the world’s output. Arkansas also produces other miscellaneous minerals such as barite, ceramic clay, chalk, gypsum, glass sand, limestone, manganese, novaculite, nepheline syenite, titanium, zinc, Tripoli, vanadium, and coal (Howard, 2011).

Figure 2.3: Location of mineral resources in Arkansas (Arkansas Geology Survey, 2014).
2:2 Climate

The climate in Arkansas is a humid subtropical climate with monthly temperature averages ranging between forty to ninety degrees Fahrenheit, and an annual average precipitation ranging from forty-five to fifty-five inches (The Weather Channel, 2012). Elevation impacts climate as well, and in Arkansas a total elevation change of 2,500 feet maximum to minimum difference in temperature of more than eight degrees. Slopes of hills and mountains also tend to be drier on the northern facing slopes (Foti, 2011). Climate can vary locally due to landforms and vegetation for example, such as flat sites are different than rolling plains, hills, or mountains (See Appendix B:17 – B:22 for reference).

The Beaver Lake area depends on rainfall for hydroelectric generation and to maintain water levels. The precipitation on Beaver Lake peaks in May at 5.10 inches and continues to have the high precipitation in June (The Weather Channel, 2014). This prepares the water levels for the summer months of June, July, and August when Beaver Lake is populated by tourists and swimmers. The number of accidents also increase during those months due to the high volume of people on the lake.

![Physiographic Regions of Arkansas](image)

**Figure 2.4:** Different topography in the state of Arkansas (Foti, 2011).
Development of Beaver Lake

Beaver Lake was created over 65 years ago, by damming the White River. The Federal Government created the Flood Control Act of 1944 that led to dams being built across the United States (USARCE, 1998). The Act authorized the Army Corps of Engineers (USARCE) to oversee water development projects, which supplemented and regulated water levels through flood control, river, and harbor acts. The Floods Control Act also limited the authorization and construction of navigation, flood control, and other water projects so as to green-light various other projects that would be more beneficial for navigation and operated with coherent river uses (USACE, 1998).

Figure 2.5: Monte Ne Amphitheater (Encyclopedia of Arkansas History and Culture, 2014).
Before the Flood Control Act of 1944 took effect, William “Coin” Harvey, who was a part of Arkansas folklore, began to build Monte Ne (The Rogers Historical Museum, 2008). He is well known for his attempt to build a pyramid and for his amphitheater that still exists in Monte Ne, Arkansas (Refer to Appendix B:15 – B:16 for images). The enigmatic amphitheater attracts visitors, especially during droughts, as the lower water levels expose remnants of Monte Ne (Fig 2.5).

![Image of Monte Ne](image1.png)

**Figure 2.6:** Harvey’s gondola and lagoon (Monte Ne, 2014).

In 1896, Harvey traveled through the nation for a presidential campaign. William McKinley defeated Harvey’s candidate, William Jennings Bryan, which prompted Harvey to leave politics (The Rogers Historical Museum, 2008). In 1900 he returned to Northwest Arkansas, where he had previously campaigned. He stated to the *Rogers Democrat* that he had chosen the area due to the fact that there were no large cities or rich people (The Rogers
Historical Museum, 2008). Harvey purchased 300 acres and named it Monte Ne, which is Spanish for “Mountain Water.” While in Spanish and Italian the name means “mountain,” in English the term is better translated as “rich man’s mountain.” He planned to build a lavish resort in 1901, and in May of the same year he opened his first hotel, Harvey had the song commissioned “Beautiful Monte Ne” in honor of the opening (Monte Ne, 2014). Harvey’s ideas became more outlandish: as time progressed he had a lagoon and canals built in front of the hotel and imported a gondola from Italy. His interest in construction continued, and he had a railroad spur from the St. Louis and San Francisco Railroad line connected to Monte Ne, claiming it was “the only place in America where a gondola meets the trains” (Monte Ne, 2014).

Figure 2.7: One of the original buildings from Monte Ne (Monte Ne, 2014).
Throughout the early Twentieth century, Monte Ne grew in conjunction with the town. A school, bank, newspaper, and numerous stores were constructed to support the businesses that the hotel generated. Unfortunately, the hotel and resort were not as prosperous as Harvey had anticipated. By 1907 the railroad was bankrupt and went under new ownership, which also failed (Rogers Historical Museum, 2008). Nearing the end of World War II, Missouri Row, the line of businesses that was built in Monte Ne, was sold to businessmen of Springdale, AR (The Rogers Historical Museum, 2008). They razed the buildings and structures of Monte Ne and proceeded with a series of structural transitions. The buildings that remained were turned into a camp for girls, then later into an antique gallery, and by 1955 it fell into disrepair as a “ghost town” (The Rogers Historical Museum, 2008).

Figure 2.8: Beaver Lake Dam shortly after completion (Beaver Lake Arkansas, 2013).
Toward the end of his life, Harvey became eccentric and believed fervently that the end of the world was rapidly approaching. He attempted to build a large stone obelisk in preparation (The Rogers Historical Museum, 2014). Harvey eventually died from intestinal influenza that led to peritonitis (The Rogers Historical Museum, 2008). All that is left today of Harvey’s resort is the concrete structure of Oklahoma Row that still stands above the lake elevation near Springdale and Rogers.

![Image of flooding](image.jpg)

**Figure 2.9:** Flooding of the Mississippi River affects an unknown area in 1927. (Neuman, 2011).

The White River has a length of 720 miles in and feeds at least eight dams, six of the dams are located in Arkansas, and travels through eighteen of Arkansas’ counties (Arkansas Department of Parks and Tourism, 2014). The White River had many settlements along its winding course. Families built farms, saw and gristmills, and tiny settlements on its banks. In 1927, a multitude of factors converged and the Mississippi river flooded parts of Arkansas. This
devastating event sparked a conversation about whether or not the White River needed a dam (Neuman, 2011). The Flood of 1927 affected over 350,000 people, reached 6,600 square miles, and impacted thirty-six Arkansas counties, where water levels reached up to thirty feet deep in some areas (Hendricks, 2011). It was rated the fourth largest flood in world history (Hendricks, 2011). Two million acres of farmland were flooded due to the rain. To alleviate flooding, speculation for a dam that would be used as flood control began in the 1930s, thereby giving rise to protests from those living alongside the river in the valley that would be covered by the impounded lake (Hendricks, 2011).

The Flood developed, much like the Dust Bowl, from manmade and natural phenomena. As with the Dust Bowl, technological advances inspired a growth in the economy. The new technologies permitted the construction of levees to maintain rivers, and drainage advancements allowed for low-lying areas of land to be turned into farms (Hendricks, 2011). The levees gave farmers and settlements a false sense of security. In 1926, instead of drought, heavy amounts of rain began to fall (Hendricks, 2011). By spring of 1927, warm weather and snow melts in Canada caused the Upper Mississippi to rise, and the Gulf of Mexico acted as a buffer rather than a release for the excess of fluid. In the South, record rainfall occurred in Arkansas; in Little Rock seven inches fell in just a few hours (Hendricks, 2011). Records indicate that the White River flowed backwards from the excess of water flowing into it from the Mississippi River (Refer to Appendix B:1 – B:2 for images). Levees broke under the pressure and surges of water (Hendricks, 2011). The devastation lasted for months afterwards; homes and factories sat in six inches to thirty feet of water and crops were decimated (Hendricks, 2011).

The Flood Control Act of 1944 put into effect many changes that occurred in the 1960s, one of which was work on Beaver Dam. The purpose was to regulate flooding near the White
River and in the Mississippi Valley. With the rising water and lake that would develop, it meant that most of the historic resort of Monte Ne would need to be demolished before it and the amphitheater were flooded by the project.

![Figure 2.10: Construction of Beaver Lake Dam (Beaver Lake Arkansas, 2013).](image)

The dam that impounded Beaver Lake produces a source of hydroelectric power for the surrounding area (Refer to images B:7 – B:13 for images of the dam construction). The dam was created with consideration to the needs of Northwest Arkansas, but it is not the only dam along the White River that was built to control flooding. After the devastation of the 1927 flood, the engineering feat of damming the White River to control the flooding was placed into effect. It was not until over three decades later, in 1960, that the Army Corps of Engineers began construction on the dam under the Flood Control Act of 1954 (USACE, 2014). When Beaver Lake construction began, it displaced many of the locals who had to leave the farms that had
belonged to their families for generations. The new dam was not only for the safety of flood control, but also for the welfare of the people. Their lives would be improved by hydroelectricity, water, and recreation. For this reason it has been discussed that the population growth through the 1970s, 1980s, and 1990s, also led to a booming industrial base in Northwest Arkansas was due in part to the creation of Beaver Lake (Hendricks, 2011).

Currently Beaver Lake is a popular site for fishing, camping, hiking, and boating. It consists of twelve developed parks, swim beaches, hiking trails, and easily accessible boat launch ramps (Beaver Lake Arkansas, 2013). It is a popular site that is chosen to fish for crappie, bream, white bass, channel, and spoonbill catfish (Beaver Lake Arkansas, 2013). In 2010 the Beaver Watershed Alliance was established to maintain water quality on the lake through conservation awareness and education programming (USACE, 2012). It is responsible for

**Figure 2.11:** Visitors on Beaver Lake Recreating (USACE, 2012).
Beaver Lake supplies drinking water to more than 420,000 people in Northwest Arkansas, it is estimated to contain 539 billion gallons of drinking water (USACE, 2012).

![Aerial Image of Beaver Lake](image)

**Figure 2.12:** Aerial Image of Beaver Lake (Beaver Lake Arkansas, 2013).

The Dam itself is located in Carroll County, Arkansas but parts of the lake extend through Washington, Arkansas, and Madison Counties, Arkansas. The hydropower plant that has a power generation capacity of 6,347,345 MWHR and the revenue generated is returned to the federal government to pay for the purchase of the dam, which had an estimated cost of 60 million dollars. The Flood control provided by the Beaver Lake dam is also estimated to have prevented 52.5 Million dollars in damage since it’s impoundment.
Figure 2.13: Army Corps of Engineers Beaver Lake Map  (USACE, 2012).
CHAPTER 3
LITERATURE REVIEW

3:1 Lakes and Reservoirs

Man-made lakes are usually created to meet the needs of human consumption, including but not limited to, drinking water, agricultural irrigation, industrial and water cooking supplies, power-generation, flood control, fisheries, and recreation. They are usually formed by constructing a dam across a flowing river, just in case the river pools behind it creating a reservoir, with Beaver Lake being an example. Other formation techniques include constructing dams on the outlets of a channel of a natural lake’s channels to control the water levels, such as in Lake Victoria, Africa and in Lake Tahoe, on the California and Nevada border (Murray-Darling Basin Authority, 2014).

The history of reservoirs began approximately 4,000 years ago in China, Egypt, and Mesopotamia, where they were constructed for the purposes of maintaining a supply of drinking water during periods of drought and flooding, and to create an irrigation system for crops (UNEP, 2013). Smaller dams were created by blocking a stream with soil and brush, very similar to a beaver dam, and once larger dams were established, they created a depression that was formed along a river by digging a channel to divert water from the river. Over time styles and new technology, changed and rudimentary waterwheels were used for power and irrigation, followed by hydroelectric power, which is the main purpose for dams today (UNEP, 2013).
There are four main types of dams used to create reservoirs: Earth-fill, gravity, arch, and buttress. An earth-filled dam is the most common, with 85 percent of the dams having heights between 15-60 meters (UNEP). Dams that are 150 meters high are usually arch dams and only exist 40-50 percent worldwide (UNEP). Arch dams are built at a constant angle. This means that as the channel grows narrower towards the bottom of the dam the central angle subtended by the face of the dam becomes smaller, as found at the Jones Falls Dam in Canada. The most commonly used dam in the United States is the gravity dam, where the force that holds the dam in place against the pressure from the water is Earth’s gravity pulling down on the mass of the dam. The water presses laterally on the dam, while the dams weight counteracts the force.
3:2 Hazards of Dams

Dams are created obstacles with the purpose of storing water or liquid-borne materials as a source for water control. When a dam fails, it is usually sudden with massive amounts of damage, the result is flooding. Below is an image captured from remote sensing using bands of the spread of water after a dam collapse. There are more than 80,000 dams in the United States, according to the 2007 update to the National Inventory of Dams (USACE, 2014). Approximately one-third of these pose a “high” or “significant” hazard to life and property if failure occurs (USACE, 2014).
There are various factors that pose a threat to a dam’s structural integrity. Intense storms may produce a flood in a few hours or even minutes in upstream locations. Flash floods, or rapid flooding of geomorphic low-lying areas, can occur within minutes to hours of the beginning of heavy rainfall or slow moving storms (NOAA). Additionally, Flash floods can raise six-inch deep creeks up to ten feet in mountainous areas (NOAA). Dams and levees are also dangerous areas during times of flash floods, and dam failure may occur within six hours of the first signs of breaching (NOAA). Other failures and breaches can take days and weeks to occur because of debris jams of objects such as trees, logs, trash, or the accumulation of melting snow in more northern areas.
3:3 U.S. Government Agencies and Impounded Lakes

The (USACE) has over 37,000 employees, both civilian and military, working to maintain engineering services to customers in 130 countries (USACE, 2014). A Federal Agency that works under the Department of Defense, the Army Corps was formed in 1775 as a military division with a separate division formed in 1779 to build fortifications near Boston (USACE, 2014). Officially, the USACE, civilian and military side, was brought into existence in 1802 when Thomas Jefferson authorized the Army Corps of Engineers Militant Academy at West Point (USACE, 2014). Until 1838, the USACE consisted of only military personnel and was used for mapping, surveying navigational routes, creating coastal fortifications, and construction of federal civil works, such as dams and parks (USACE, 2014).

The USACE evolved over the years, becoming more involved with civilian projects, hydroelectric energy, and other non-military endeavors (Refer to Appendix B:3 – B:6 for safety campaigns). Environmental sustainability is now the guiding principle, in addition to dam maintenance. The modern role of the Corps is to energize the economy by maintaining America’s waterways, to support local government and business, and to provide recreational opportunities with campgrounds, lakes, marinas, and trails (USACE, 2014).

The Arkansas Game & Fish Commission is another government agency, it was formed on March 11, 1915 for the purpose of maintaining game populations were declining of conservation efforts, as well as over-hunting and over-fishing were destroying the habitat and endangering species, and there was also a lack of conservation efforts that contributed to the declining game population (Arkansas Game & Fish, 2011). Arkansas Game & Fish, the 2012 reports state that the purpose of Commission today is to manage wildlife and natural habitats as well as regulate
hunting, fishing, and trapping. The agency accomplishes this by working with public, private, local, state, and federal agencies to maintain species populations and habitats.

The first thirty years after the creation of Game & Fish Commission were very turbulent, as the government had yet to establish the flexible regulations the agency needed in order to evolve with the changing wildlife and habitat programs. Amendment 35, in the Constitution of Arkansas, was passed in 1944 in order to grant the Game & Fish more authority to enact and maintain the established fishing and hunting laws (AGFC, 2003). Before Amendment 35 was passed, game wardens had the right to inspect hunters but did not have arrest authority or the right to issue citations, essentially making them powerless, and these laws changed with the elected government representatives and their voters (Williams, 2010). After Amendment 35, the Commission had autonomy from the state to enable regulations and enforcement on a statewide basis and thereby gained citation and arrest authority (Williams, 2010). Later, Amendment 75 was passed in November 1996 and went into effect July 1, 1997, allowing for a conservation sales tax that designated 1/8th of 1 percent of the state’s general sales tax for the Arkansas Game & Fish Commission (Williams, 2010).

Currently, the Game & Fish Commission is maintained by a board of seven governor-appointed commissioners who serve seven-year terms. Meetings are held at the agency headquarters in the Little Rock, Arkansas office every third Thursday of each month and led by a governor appointed director.

The United States Coast Guard monitors most major water bodies in the United States, not just open waters. The awareness campaign for waterway safety is not only a local concern that began with Beaver Lake. Recently, the Coast Guard began a “Wear it” campaign, which other agencies, including the USACE, have adopted. Billboards and advertisements have been
set up over North America to educate Americans about boating hazards, safety, and the importance of wearing one’s life jacket. The 2012 Game & Fish Annual report provided statistics on the number of fatalities, causes of death, whether life jackets were worn, and injuries in the United States (Department of Defense, 2013). The top ten known causes for accidents were: operator inattention, operator inexperience, improper lookout, machinery failure, excessive speed, navigation rules violation, alcohol use, force of wake/wave, weather, and hazardous waters (Department of Defense, 2013). The statistics are separated by a series of criteria from the Federal government being “Reportable or Non-reportable” accidents. All accidents must follow the “Casualty and Accident Reporting Guidelines” (Department of Defense, 2013). The federal government and most states consider an accident to be when the “vessel” is involved with a death, missing person, personal injury, property damage, or total vessel loss resulting from the vessel’s operation, construction, equipment, or machinery (USCG, 2012).

**3:4 History**

Located in northwest Arkansas along the White River is Beaver Lake. Constructed by the USACE following the Flood Control Act of 1944, construction on Beaver Dam began in 1960 (USACE, 2012). Finished in 1966, Beaver Lake spans 28,370 acres across the Ozark Mountains, close to Eureka Springs then flowing down to the northern side of Fayetteville; the lake covers approximately 487 miles of shoreline (USACE, 2012). Known for ample fishing and recreational opportunities, Beaver Lake is maintained by numerous state and federal agencies. The USACE is the most ubiquitous agency on and around the lake. It owns 2,008 acres of campgrounds in the surrounding area, including swim beaches, boat-launching ramps, picnic shelters, trails, and 650 individual campsites over twelve parks (USACE, 2012).
**3:5 Risk Assessment and Perception**

The effort to lessen the loss of life and property by reducing the impact of disasters using risk analysis is mitigation (FEMA, 2011). Considering the risk, reducing risk, and insuring against risk are a few of the considerations of mitigation. Long-term health requires the acknowledgement of risks and addressing the hazards (FEMA, 2011). Impounded lakes have been heavily populated, especially during the summer months. As the man-made and natural lakes and shorelines become populated and highly used, many obstacles and hazards are prevalent to the visitors. Accidents, deaths, and economic loss occur at high rates. Libations are the most obvious theory as the cause of accidents on lakes, but there are other factors such as education, sex, age, and attention that require further study. Federal governments worked to ensure the public’s safety and education when they first initiated the construction of dams; they planned for the future to protect land and people from floods.

The analysis of risk perception started in the 1970s as part of the study of psychology (Slovic, 2000). Most studies involving risk perception are based on age, education, and gender effects with effects of social, political and cultural factors playing an important role (Slovic, 2000). Hazards have focused on four main questions for over fifty years: 1) What is the human occupancy of hazard zones? 2) How do people and societies respond to environmental hazards and what factors influence their choice of adjustments? 3) How do you mitigate the risk and impact of environmental hazards and lastly 4) Are societies becoming more vulnerable to environmental hazards (Cutter, 1996)?

The United Nations (UN) started the International Decade for Natural Disaster Reduction (IDNDR) in 1987, which uses vulnerability for assessment of potential damage and loss of life from hazardous events (Cutter, 1996). There is a developmental-based vulnerability reduction
plan to reverse the poverty, population, development, and environmental degradation (Cuny, 1983). Vulnerability has been used in personal risk and hazard disaster literature in previous works, such as Gilbert’s work (1995), but now occurs more often in environmental, global change, and development studies Dow, 1992; Dow and Downing, 1995). Geographers have been studying the vulnerability concept since the 1980s, which indicates that they started to address the concept a decade before other researchers (Cuny, 1983).

There are individual and social vulnerabilities that have both spatial and nonspatial fields. 

Social vulnerability refers to social groups or society at large from hazardous events. It includes the interaction of society with biophysical conditions that later affect the resiliency of the environment to react to hazards or disasters, which in turn affects how the public responds (Cutter, 1996). There are two ways that the studies interpreted vulnerability: through social events that are not related to the event itself, such as a natural disaster, and through proximity to the disaster. Social events are based on three things: entitlement, empowerment, and political economy (Cutter, 1996). Additionally, Cutter dissected vulnerability into three parts: the risk/hazard exposure, vulnerability of social response, and vulnerability of places. The first vulnerability addresses the preexisting condition of a hazard and how the human occupation of that place can amplify the risk/hazard exposure. The second part, social response, showed the public’s response to a risk/hazard and their mitigation techniques. The cultural and historical society, and the economic position of the area affected influenced this vulnerability. Vulnerability of places is more geographical in terms, because its basis is the biophysical risk and social response within a geographic location (Cutter, 1996).
Many threats exist worldwide, but in the past one hundred years it is considered safer because of modern day scientific advances. Life-threatening diseases have been practically eradicated, and life expectancy has increased while infant deaths have decreased. However, with new technology have come new threats. Immunity to antibiotics has posed a new threat as a virus can mutate faster than scientists can create (mutate) new, more powerful antibiotics to combat it (Ropeik, 2002). Threats such as bird-flu, hazardous waste disposal, nuclear power plant failure, and ozone depletion have become life-threatening risks. Increased risk awareness has provided people with new knowledge about what is lurking behind the corner and mold. Access to instant facts, whether factual or misinformed, has caused people to perceive the world as more dangerous today than ever before. Sir Arthur Conan Doyle summed it up best in the *Hounds of Baskerville* (1902), “That which is clearly known hath less terror than that which is hinted at and guessed” (Doyle, 1902).

There are four components to risk: probability, consequences, presence of a hazard, and exposure (EPA, 2012). Probability risk is the likelihood that the risk will occur. If you smoke a pack of cigarettes a day, statistics indicate that you will get cancer (American Cancer Society, 2014). If there is a nuclear power plant meltdown, radiation will affect those living in the area, this is a consequence risk (Chernobyl Accident 1986, 2014). If an activity is not a hazard it does not present a risk. If smoking does not cause cancer, then there is no risk (Ropeik, 2002). The final component, exposure, is similar to hazard. If the problem does not present a hazard, there is no risk. For example, Wisconsin does not have hurricanes, therefore there is no risk. Considering the characteristics of the four elements of a hazard is circumnavigated by asking questions of oneself. What is the range of exposure? What is the range of consequence? How do I reduce the risk to myself?
3:6 Perception

To expound on risk perception, humans respond to risk based on how they perceive that risk, and their perception predicts how they will react (Mileti, 1993). Quantitative risk is a numerical value that assesses perception and requires the calculation of two components of risk, whereas the qualitative risk is based on an opinion, anecdote or characteristic of risk rather than numerical data. Both types of risk perception are considered important in providing accuracy and data for risk assessment. In the Beaver Lake Study, surveys were assessed using both qualitative values and quantitative data.

Risk perception is the study of the numerous factors that the percipient or affected populace considers to be a risk or hazard by analyzing those dangers and how the public responds to them. The risks can foment diverse different responses depending on gender, age, socioeconomic status, education, etc., and risk perception monitors these responses. The noted Swiss psychologist Carl Jung concluded that the human brain functions using two distinctive domes: perception and judgment (Jung, 1936). Perception is tied to the past and is stored in three regions in our psyche: context, experience, and knowledge (Jung, 1936). Perception may also deal with how humanity acquires information and functions in a material world, while judgment determines how people arrive at their conclusions, and how they perceive those conclusions. Humans react to risks and hazards in ways that correlate to their perception of the risk. It is their perception that influences behavior or action and is crucial in understanding high-risk behavior on Beaver Lake (Mileti, 1993).

In order for hazard preparedness to be effective, the public perception must be understood in order to create an impression. Residents often have inaccurate beliefs about the hazard and its impact on themselves and surroundings (Lindell and Perry, 1993). This may be an
indication why visitors and boaters to Beaver Lake still drink alcohol or allow for distractions. Their previous experiences have not produced a negative impact; therefore there is no reason for caution. A 1977 study showed that in order for evolved actions to occur, a person must be motivated by cognizance of the hazard, have knowledge of how it could affect the community, and be personally liable for the consequences (Janis and Mann, 1977).

Repeated exposure to hazard-relevant information does not instinctively elicit attention and comprehension, let alone the acceptance, personalization, and retention required to initiate hazard adjustments (Mileti and Sorensen 1987). However, Lindell and Perry (2004) stated that the public does not need to understand the hazard to be motivated to be proactive, but that a belief needs to be established that the hazard exists and preventative measure is needed. Riley and Newby (2006) studied the theories behind risk perception, and notes that risk perception pertains to a vast variety of subjects: race, gender, ethnicity, culture, and socioeconomic status, as well as to different issues, from environment to car accidents.

Boholm, (2007) defined risk as being extremely contextual and fluent and that what is not considered a risk depends on interpretation, the relationship of risk between a risk object and an object at risk. Many relationships exist that mold risk, including: social relationships, power relations, hierarchies, cultural beliefs, trust in institutions and science, knowledge, experience, practices, and memories. Slimak and Dietz (2006) explained that risk perception is not nearly concrete as one would believe and that the field is more about searching for an explanation for itself. Roser (2006) used a three-stage development for risk involving initial suitability by the assessment of historical data, then revising the perception based on new data, and finally characterization of the hazard.
Another factor in risk perception is the social amplifications of risk framework (SARF). The SARF was first introduced in 1988 by researchers, Kasperon, Renn, Slovic, and colleagues. There are five principal publications used as the theoretical foundation for SARF. The framework was established to also address social processes underlying risk. Sociopolitical activity in a population that receives low risk but attains more public notice is labeled as risk amplification, whereas risk attenuation is a high-risk hazard that received little attention. There was also a proposed “signal value” by Fischoff, Lichtenstein, and Slovic (1980) as cited in *The Social Amplifications of Risk*. Hazards in the classic psychometric dread/knowledge factor elicit a high signal value as a warning for society that the events would occur again or worse events would occur in the future.

The statistics of the National Parks illustrate some examples of risk perception and actual hazard. The issue of risk perception and assessment on recreational lakes is vital to public safety and economic stability, and there have been many studies on the subject. However, no studies were found that focused on Beaver Lake and the surrounding area. This lack of map risk perception with actual safety and accident statistics for the area may provide insight into specific problems and for that reason was undertaken.

National Parks are one of America’s best resources and were created for the public to enjoy. There are 401 National Parks in the United States, with approximately 280 million visitors to the parks each year (USNPS, 2014). The National Park System owns 84,000,000 acres of land, of which 4,502,644 acres are oceans, lakes, and reservoirs. There are 85,049 miles of perennial rivers and streams and 43,162 miles of shoreline (United States NPS, 2014). The are of the United States National Parks owns is huge, so there are more places for visitors to be exposed to hazards. Due to their various locations and topographies, the National Parks can be
hazardous. The National Parks are chosen based on their unique beauty, heritage, and historical value. They provide many opportunities for pasttimes and recreation such as hiking and mountain climbing, which also demand that visitors be knowledgeable of their surroundings and of potential threats. Granite cliffs in Yosemite rise 3000-4000 feet from the valley floor; the Buffalo River provides class II-III rapids during high water seasons. These sites provide various levels of recreational activity and draw in many daredevils or simply vacationing families which increase a persons’ risk from the activities provided by the locations. Heggie’s (2008) research the number of fatalities in National Parks and the months in which they occur. Of the fatalities, he studied seventy-three percent of fatalities that occurred in the parks are United States citizens.

**Table 3.1:** Number of fatalities in the National Parks based on month (Heggie, 2008).

Heggie (2008) studied hazards for the National Parks and has devised numerous approaches that were used as a model for this Beaver Lake Risk Assessment. Search and Rescue (SAR) is an element that is vital for the National Park Service. From 1992 to 2007, 78,488
people were involved in 65,439 SAR occurrences (Heggie, 2008). The fatalities during that
time amounted to 2,659; 24,288 injuries and 12,212 rescues. It was calculated at 11.2 Search
and Rescue (SAR) occurrences each day. The most common activities that required the service
of SAR were hiking at 48 percent, boating at 21 percent, suicides at 12.1 percent, swimming at
10.1 percent, and boating at 10.1 percent (Heggie, 2008).

Table 3.2: Reported visitor activity at the time search and rescue operations were initiated

<table>
<thead>
<tr>
<th>Type of Hazard</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foul play</td>
<td></td>
</tr>
<tr>
<td>Climbing—technical unroped</td>
<td></td>
</tr>
<tr>
<td>Hunting/gathering</td>
<td></td>
</tr>
<tr>
<td>Snow vehicle</td>
<td></td>
</tr>
<tr>
<td>Skiing</td>
<td></td>
</tr>
<tr>
<td>Canyoneering</td>
<td></td>
</tr>
<tr>
<td>Climbing—scrambling</td>
<td></td>
</tr>
<tr>
<td>Boating—nonmotorized</td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
</tr>
</tbody>
</table>

Aristotle wrote, “The places where they rise were once dry, and there is a limit to their
operations, but there is none to time. So also of all other rivers; they spring up and they perish;
and the sea also continually deserts some lands and invades others” (Shields, 2014). He was the
first to observe the composition of land and formulated the theory that the Earth changes at a
slow rate and that those changes cannot be observed through one persons’ lifetime. Therefore the
data gathered for this study from Beaver Lake will span from its inception to the present day, so
that there may finally be a comprehensive study of the risks and perceptions of safety on such a popular destination in Northwest Arkansas, as Beaver Lake.

3:7 Recreation and Water Risk

Skiing, swimming, boating, and scuba diving are all some of America’s favorite hobbies on lakes. With these recreational activities comes great risk, especially when there are distractions involved such as the Game & Fish Reports hazards, alcohol, phones, lack of education, lack of experience, and dehydration.

Boating is comparable to driving in that anyone who is driving the boat should have their full mental capacities. Unfortunately, boaters frequently indulge in alcohol abuse. Alcohol causes the same problems that it would for someone driving a vehicle: lack of focus, attention, poor motor control, and poor perception. Bell (2000) discussed the correlation between uneducated boaters who were drinking and educated boaters who were drinking. The study showed that trained boaters were actually a higher risk than the non-trained.

An estimated 4,000-5,000 Americans die from drowning every year and of those who drowned, one-fifth were boating related (Bell, 2000). (Refer to Appendix B:23 and B:24 for statistics on drowning death rates in the United States). The major risk perpetrators for drowning and injuries were men younger than thirty years of age. The study showed that they were inexperienced in boating and that they failed to use a personal flotation device, (PFD) not to mention the excessive use of alcohol consumed while boating. There is little research that examines the influence of alcohol in boating injuries and fatalities. One of the few case-controlled studies was in California from 1988-1989 (Smith, 2001), where it was shown that recreational boaters who died were three times as likely to have been drinking versus the controls, and were 10.6 times as likely to have blood alcohol levels in surplus of 0.1. In
Arkansas, a person is legally intoxicated when he/she has a BAC of .08 or higher. A study in Beaufort County, North Carolina showed that boaters with safety education had a higher use of alcohol, 53 percent versus 38 percent (Glover, 1995). The study concluded that even with boater education the level of drinking would not change, as alcohol-related boating accidents receive little attention or educational prevention unlike drinking and driving while operating a vehicle.

3:8 Water Safety Statistics

When researching water safety statistics a variety of sources appeared, but the vast majority of prior studies only involve water quality rather than hazards encountered while participating in activities on the water. Water quality is an issue and one that should be given attention and concern, but recreational events should not be overlooked or dismissed.

Figure 3.4: Boat Crash on Beaver Lake (Brunsgaard, 2012).
The Center for Disease Control and Prevention (CDC) conducted a survey concerning drowning from 2005-2009; they stated that drowning is the leading cause of unintentional death worldwide and that the highest rates occur among children. It also claimed that drowning is the leading cause of injury and death among children aged one-four years, and that they drowned in swimming pools (CDC, 2014). Men had a higher drowning rate than women at 2.07 per 100,000 population, versus women who were 0.54 per 100,000 (CDC, 2014) Men made up eighty percent of deaths from drowning (CDC, 2014). The variations in race/ethnicity were greatest among children five-fourteen years with black children at 1.34, Hispanic at 0.46, and white children at 0.48 (CDC, 2014). Most of the accidents that involved people aged fifteen or older involved alcohol.
3:9 Summary

As one of the more populated areas in Northwest Arkansas, Beaver Lake is heavily visited, which makes it vulnerable to accidents and deaths. In 2013 there were eight deaths on Beaver Lake, but that did not stop more deaths in 2014 (Larry, 2014). It is essential in risk perception studies to understand and cope with the dangers of the modern world (Slovic, 2000). A public understanding of risk misconceptions must be identified in order to correct the problem with issues to be considered may include societal risk taking, decision-making in mental health law, rating risks, facts versus fears, informing and educating the public about risk, and perceived risks (Slovic, 2000). By studying risk perception of Beaver Lake and how it varies year to year and in comparison with other impounded lakes, policies and plans can be constructed to improve the safety for the public.
CHAPTER 4

METHODOLOGY

Using questionnaires to assess the gap between facts and opinions has a strong history of effectiveness and accuracy. Heggie (2009) conducted numerous hazard and risk assessment surveys using a well-formed technique that has proven effective. He began with gathering data from Annual US National Park Search and Rescue Reports from 1992-2007. Once a Search and Rescue (SAR) mission is activated, a case incident report (NPS form10-343), a supplemental case report (NPS form 10-344), and a rescue funding report (NPS from 10-347) must be filled out (Heggie, 2009).

These reports were then summarized and filed as an annual report to a regional office (Heggie, 2009). Heggie then only used the reports that were consistent with the required criteria and compiled them into corresponding charts and graphs. The problem that occurred with Heggie’s data is that not all of the annual report could be used. He only included the data reports that had been completed, meaning that the report specified what kind of SAR operation occurred, and what SAR classification (fatality, illness or injury, non-injury or illness) it was. Some of the forms lacked the completed data, and were therefore excluded from the published document. This left a small margin of error for the accuracy of the charts and graphs.

In this Beaver Lake Study, surveys were administered to the local and federal government agencies that are involved with patrolling, maintaining, and keeping Beaver Lake safe: The Arkansas Game & Fish, the Army Corps of Engineers, and the Benton and Carroll Police Departments. Safety has been one of the main concerns on Beaver Lake since its impoundment and formation in the 1960s. It is a hub for summer and fall recreational activity and poses concerns regarding the safety of visitors that come to enjoy the facilities and area
(Beaver Lake, 2014). Using Heggie (2009) models, surveys were distributed in the same manner among the agencies, responsible for Beaver Lake Safety.

Figure 4.1: Overview of Beaver Lake (Beaver Lake Arkansas, 2013).

The study location and size mean that it is probable that future incidents for deaths and physical harm, among other accidents will occur on and around the lake. With this knowledge, the idea of agency members giving their opinions on accidents and where they are occurring is vital for the assessment of the safety of visitors and future policies in the region.

During the summer and fall of 2013, there were six deaths due to drowning on Beaver Lake. A hypothesis correlating the relationship between recreational activities and danger was fabricated as a result of the deaths. Records dating back to 2003 provided by the Arkansas Game & Fish agency were used to assess their findings. Any documents predating 2003 were complicated to
obtain. The use of the records data revealed the physical facts but not the motivations behinds the accidents and fatalities because the data did not reveal any extenuating circumstances pertaining to the accidents. Local Police Departments, Army Corps of Engineers, and the Arkansas Game & Fish Commission were also surveyed. The survey was created and tested on University of Arkansas professors, staff, and students. Once modified, the survey was administered throughout government agencies around Beaver Lake to approximately 60 agency employees. The surveys were conducted and personally administered with the assistance of the Army Corps of Engineers of Rogers. The surveys employed Likert scaling technique using a gradient gauge response, allowing for the surveys to be speedily and easily quantified for descriptive and connotative statistical analyses (Paradise, 2006). In addition to questions were asked on deaths and accidents on Beaver Lake, there were demographic questions regarding age, sex, birthplace, and education level. The remainders of the questions were Likert based (a psychometric scale) to gauge general knowledge on perceived threats to the area (regarding age and sex). A range of 1 to 10, (1= I know nothing, I disagree, no, or danger does not exist, 10= I know everything, I agree, yes, or the danger is great) was designed. (See Appendix B). The scaled responses of the Likert scales mean that each response can be assigned a numerical value, creating a measurable gradient for statistical analyses and the assessment of perception changes (Haring,1992).

Surveys were administered to Carroll, Benton, and Washington County Sheriff departments as they were responsible for SAR crews for emergencies on Beaver Lake. I also administered surveys to Game & Fish employees and the Army Corps of Engineers.
The surveys were specifically administered through related local and federal agencies, in as much as they have jurisdiction and authority on the lake, and are most educated and trained to respond to, and deal with the dangers on Beaver Lake. The surveys were administered throughout late summer and fall, July 2013-January 2014, because most law enforcement and rangers, including seasonal rangers, were working during that time (USACE, 2014). Some of the surveys were dropped off at the local Police Departments, Rogers, and Bentonville where they were scanned and emailed back others were handed out to government agency officials at their offices and respective places of work i.e. marinas, parks, and camps. It took some time to get other surveys returned in a timely manner; most rangers work on outdoor patrols and were not in
the office. Of the 60 surveyed administered; only 36 were returned. Whereas it is a stronger assessment tool to have a random sample of civilian opinions as well, with time, funding, and access to information restraints created by the study site and data availability, it was more appropriate and practical to distribute the surveys systematically with the intention of creating a balanced sample among agency employees. Once all of the surveys were collected, the responses were placed into a tabular format spreadsheet, and the data were analyzed using SPSS statistical analysis. SPSS analyzes data to divulge correlations, patterns, and trends. All of the data were compiled statistically, cartographically, and graphically.
CHAPTER 5
RESULTS AND DISCUSSION

The purpose of the study of the past hazards and risk assessment of Beaver Lake was to specifically survey the agencies involved with keeping and maintaining the safety on the lake. Numerous lives are lost every year on Beaver Lake due lack of education, bad judgment, which may be due to alcohol or dehydration, and distractions. The study was intended to provide data and ideally divulge any gaps found in the perception of where and why accidents were occurring, is believed to occur and were actually reported as having occurred. The chapter is divided into sections, discussion and analysis of demographics, analysis of questions, analysis of the Likert scale used, and cartographic representations of accident awareness.

The demographic findings of the survey were limited. Demographic data should include quantifiable subsets within a given population that could be used to characterize and correlate a population. It included sex, age, ethnicity, languages, disabilities, employment, and location. The perception of the agency employees included a limited number of females (6 of the 36 surveyed), which skews its results and while the age bracket was slightly more diverse, it was still limited between the ages of thirty and mid fifties.

All related agencies discussed in this research have first-hand experience keeping Beaver Lake safe, except the Northwest Planning Commission, which oversees lake planning, mapping, and jurisdiction support in their Rogers office. Initial speculation for the cause of poor water safety was attributed to two causes 1) the lack of education; and 2) alcohol. Some of the open answer questions revealed or mentioned the options none, or no concerns, suggested that lack of education was the more dominant cause.
5:1 Analysis of the Demographic Data

Only one survey respondent, (Table 1) had been personally involved in an accident on Beaver Lake, although many had witnessed accidents on Beaver Lake. There were five witnessed accidents on Beaver Lake in summer 2013 by the Army Corps of Engineers. In general, the Army Corps of Engineers has 1-2 minor accidents (accidents that did not involve injuries or death) every summer, but those accidents were not reported to the Army Corps of Engineers office or to the headquarters in Little Rock, therefore they are not deemed accidents on Beaver Lake.

Table 5.1 Number of agency employees working on Beaver Lake that were involved in an accident on Beaver Lake

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Number of People who were in an Accident on Beaver Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
<td>4</td>
</tr>
<tr>
<td>Benton County</td>
<td>8</td>
</tr>
<tr>
<td>City Planning</td>
<td>6</td>
</tr>
<tr>
<td>Game and Fish</td>
<td>2</td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td>10</td>
</tr>
</tbody>
</table>

The age demographics for the agency employees involved were diverse; most were between the ages of twenty-five and forty, (44%). Age affects answers since older respondents’ >60 years old (11%), beliefs, morals, and experience, could all affect key answers (Greif, 1994).
A person who grew up in the 1950s-1970s could have a drastically different perspective than a person who spent their childhood in the 1980s-1990s as family roles, jobs, economy have evolved since those earlier times (Phillips, 2014).

Table 5.2 Age range of agency employees working on Beaver Lake

<table>
<thead>
<tr>
<th>Age of Employees at Surveyed Agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of People</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt;20</th>
<th>20-30</th>
<th>31-40</th>
<th>41-50</th>
<th>51-60</th>
<th>61-70</th>
<th>71 and over</th>
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<tbody>
<tr>
<td>Carroll County</td>
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<td>Benton County</td>
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<td>City Planning</td>
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</tr>
<tr>
<td>Game and Fish</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The agency employees surveyed were heavily male dominated (83%), and most were native-born Arkansans. Very few females were involved with the survey; only six of the respondents were women. The birthplace demographics showed that those surveyed came from Arkansas and claimed to be from a city. This part of the survey is more likely highly flawed, as it is based on personal opinions, and not on strict definitions of a city, town, or country. The concept of a city, town, or country is widely open to judgment of the individual.
Gender prejudices or social dynamics also can be included in the answers and responses obtained from the agencies. It could be the ego, conscious mind, or the subconscious that influenced the answers were chosen, it surveyed the southern United States with eight gender-related questions from the NORC General Social Data Survey (Rice, 1995). The results explained that the Southern portion of the United States still holds to more dated (conservative) views on gender roles regarding women in the workplace and politics. Of the ninety-nine accidents reported from 2003-2011, only sixteen were operated by females. Sixteen of the thirty-six agencies were of the general opinion that men were not at higher risk to cause accidents, that is four out of every nine by sex, almost half of the surveyed group, which was predominately male.

**Table 5.3** Range of male to female agency employees working on Beaver Lake

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
<td>6</td>
</tr>
<tr>
<td>Benton County</td>
<td>9</td>
</tr>
<tr>
<td>City Planning</td>
<td>5</td>
</tr>
<tr>
<td>Game and Fish</td>
<td>4</td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td>8</td>
</tr>
</tbody>
</table>

![Bar chart showing the number of male and female employees for each agency](chart.png)
Most of the agency employees surveyed considered themselves to be raised in a city. This survey demographic is considered flawed though. The definition of a city, town, or countryside is left to the individual and did not have a firm definition. Although 80% of agency employees considered themselves born in a city, the definition of a city could be ambiguous based on their perceptions.

Table 5.4 Demographics on how many agency employees are from towns, cities, or rural areas

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
<td>5</td>
</tr>
<tr>
<td>Benton County</td>
<td>1</td>
</tr>
<tr>
<td>City Planning</td>
<td>4</td>
</tr>
<tr>
<td>Game and Fish</td>
<td>3</td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td>5</td>
</tr>
</tbody>
</table>

All of those surveyed were educated but very few (2), were educated beyond the four-year college degree level. The levels of education were diverse, with high school and college graduates dominating the outcomes. The Army Corps of Engineers has the most college graduates, 70% of their employees had at least a four year degree and 10% had obtained a post-graduate degree. The Northwest Arkansas Planning Commission had the most post graduate-
educated respondents (83%), as was natural in their line of work requires a more extensive training.

Table 5.5  Education levels of agency employees working on Beaver Lake

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
<td>0</td>
</tr>
<tr>
<td>Benton County</td>
<td>1</td>
</tr>
<tr>
<td>City Planning</td>
<td>2</td>
</tr>
<tr>
<td>Game and Fish</td>
<td>5</td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td>6</td>
</tr>
<tr>
<td>none</td>
<td>0</td>
</tr>
<tr>
<td>some school</td>
<td>0</td>
</tr>
<tr>
<td>high school</td>
<td>5</td>
</tr>
<tr>
<td>some college</td>
<td>3</td>
</tr>
<tr>
<td>college</td>
<td>1</td>
</tr>
<tr>
<td>grad college</td>
<td>0</td>
</tr>
</tbody>
</table>

The income levels were diverse, most (75%), were in the $20,000-$64,999 range. City Planners and Engineers were the most highly paid, while Carroll County (17%) and Benton County (27%) Sheriffs received the lowest pay grade. The Army Corps of Engineers is the only federally funded agency of the groups involved in the survey, their base pay is based off of the General Schedule (GS) system used by the federal government. The GS is based off of the yearly National Defense Authorization Act which is used by a guide by the Secretary of Defense to
increase the annual limitation on premium pay (USACE, 2012). The other agencies were state or local and their pay grade is based off of local tax.

Table 5.6 Income levels of agency employees working on Beaver Lake

<table>
<thead>
<tr>
<th>Income Levels</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20,000</td>
<td>1</td>
</tr>
<tr>
<td>20,000-34,999</td>
<td>2</td>
</tr>
<tr>
<td>35,000-49,999</td>
<td>3</td>
</tr>
<tr>
<td>50,000-64,999</td>
<td>4</td>
</tr>
<tr>
<td>65,000-80,000</td>
<td>2</td>
</tr>
<tr>
<td>&gt;100,000</td>
<td>1</td>
</tr>
</tbody>
</table>

5:2 Analysis of Questions

Question 1 asked employees when the last accident occurred. Knowledge of accidents fluctuated with every group surveyed. The awareness of the last accidents was very low in the Carroll County Sheriff Department. The majority who were surveyed said “none,” or were only familiar with the northern portion of Beaver Lake, where they are located. Those surveyed in Carroll County were on the rescue diving team, which operates on a volunteer basis. The Army Corps of Engineers employees were almost unanimous in their perception (72%) that the most recent accident occurred last month. It is noted that the Army Corps of Engineers employees
were surveyed in August the accident occurred in July. The rest of the surveys were spread regarding the opinion that the last accident occurred last year or this year; the Carroll County Sheriff’s department had a 16% response that it was last year, and 66% responded with unknown; Benton County Sheriff’s Department had a 43% response with last year Roger City Planning Commission had a 43% response with last year; and Game & Fish Commission had a 33% response with last year.

Table 5.7  Agency employees awareness of accidents

![Chart showing agency awareness of accidents]

Question 2 asked employees about their knowledge regarding the cause of the accident. The results of the perception of the believed accident causes was 42%, of the respondents considered alcohol to be the cause, with “none” identified at 41%, and 2% considered all of the options. There was an open answer option that was included with question 2. The explanations that were included in the open answer for those who answered none consisted of: being elderly,
operator inattentiveness, natural causes, no life jacket, unknown, and lack of lake channel knowledge. Lack of education was unexpectedly the third reason, only 10% of agency employees identified this as a cause, but in reality the majority of boaters do not have formal training. None of the agency employees chose dehydration or texting as a cause of accidents. Consideration was taken into account that employees who work on Beaver Lake should be based on first-hand experience, knowledge, and a stronger relationship to reality.

**Table 5-8: Agency employees’ perception on what the cause of accidents were**

<table>
<thead>
<tr>
<th>Believed Cause of Accident</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>alcohol</td>
<td>2</td>
</tr>
<tr>
<td>dehydration</td>
<td>7</td>
</tr>
<tr>
<td>texting</td>
<td>1</td>
</tr>
<tr>
<td>lack of education</td>
<td>2</td>
</tr>
<tr>
<td>all of these</td>
<td>1</td>
</tr>
<tr>
<td>Diving</td>
<td>0</td>
</tr>
<tr>
<td>none</td>
<td>3</td>
</tr>
</tbody>
</table>

Question 3 targeted the awareness of the area in which the most accidents occurred. The two most perceived locations of accidents were segregated to Prairie Creek (25%), one of the most visited swim beaches, and the City of Rogers. Prairie Creek also has the largest campground on Army Corps of Engineer property, offering more than 100 campsites, as well as a heavily popular boat launch ramp. The rest were evenly distributed throughout the middle
portion of the lake, the location of Prairie Creek and Rocky Branch (14%), the North portion, where Starkey, Lost Bridge, and Eureka Springs are located (14%), and South portion of the lake, where Horseshoe Bend, Monte Ne, Hickory Creek, Springdale, and Lowell are located (11%).

Table 5.9 Agency employees’ perception on where accidents occurred

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
<td>4.5</td>
</tr>
<tr>
<td>Benton County</td>
<td>2.5</td>
</tr>
<tr>
<td>City Planning</td>
<td>2.0</td>
</tr>
<tr>
<td>Game and Fish</td>
<td>1.5</td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Question 4 asked “what was the considered primary influence on poor water safety to Beaver Lake”. This coincided with Question 3 regarding the believed cause of accidents and which areas have the highest traffic of visitors and parties. Dehydration and texting were not chosen by any of the agency employees as a single cause, but 12% of agency employees concluded that a combination all of the options influenced the poor water safety. None of the
options provided was chosen by 2% of agency employees. Lack of education allotted for 14% of the perceived cause of accidents and 49% considered alcohol to be the leading influence of poor water safety on Beaver Lake. The Army Corps of Engineers, Northwest Arkansas Regional Planning Commission, and Benton County Sheriff’s Department were the most avid with their choice of alcohol being the cause for poor water safety. Again consideration was taken into account that employees who work on Beaver Lake should be based on first-hand experience, knowledge, and a stronger relationship to reality.

Table 5.10 Agency employees’ perception on what influences poor water safety on Beaver Lake

<table>
<thead>
<tr>
<th>Influences</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>10</td>
</tr>
<tr>
<td>Dehydration</td>
<td>3</td>
</tr>
<tr>
<td>Texting</td>
<td>2 2 2</td>
</tr>
<tr>
<td>Lack of Education</td>
<td>3 3</td>
</tr>
<tr>
<td>All of these</td>
<td>3</td>
</tr>
<tr>
<td>None</td>
<td>2</td>
</tr>
</tbody>
</table>

Question 5 was left open-ended regarding what age a boating license should be given. A license gives a person the legal privilege to drive a vehicle on roadways or water. The legal age in Arkansas at which one may obtain their license is sixteen. Operators statements indicated that on Beaver Lake there are numerous boaters who lack boating licenses. There was a common
survey perception that those with a boating license had more accidents and were more likely to be under the influence of alcohol. This is a reasonable hypothesis for this could be that they felt more in charge or control of the vessel (Arkansas Game & Fish, 2013). The ages at which a boating license should be given ranged drastically. The legal age is 16 years of age, but the opinions as to what age it should be legal spanned from twelve years old, (8%), to as high as twenty-five, (2%) responded with age 25.

**Table 5.11** Agency Employees’ surveyed perception on when boating licenses should be administered

![Chart showing surveyed perception on when boating licenses should be administered](chart.png)
5:3 Likert Scale

Questions 6-8 were based on the Likert scale for grading. Question 6 asked about the consideration on the water safety on Beaver Lake being regarded as excellent and was graded 1: being I fully agree, 2 being somewhat agree, 3 being neutral, 4 being somewhat disagree, and 5: being I fully disagree. Most of the agencies considered the water safety excellent on Beaver Lake (25%) while 6% fully disagreed. The Army Corps of Engineers had the most agency employees who fully agreed that water safety was excellent (50%). The sheriff’s offices were ambiguous in their answers, neither fully agreeing nor disagreeing: 27% were neutral, 23% somewhat agreed or somewhat disagreed. Most other agencies were neutral such as Northwest Arkansas Planning Commission at 43% neutral. Only 14% of Northwest Arkansas’ Planning commission fully agreed. Benton County Sheriff’s Department had the most ambiguous answers as all of the agency employees surveyed answered neutral, somewhat disagree, and somewhat agree. The perception of the Game & Fish office was spaced out equally among neutral, somewhat agree, and fully agree.

Table 5.12 Agency Employees’ perception on quality of water safety

<table>
<thead>
<tr>
<th>Consideration that Water Safety on Beaver Lake is Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
</tr>
<tr>
<td>Fully agree</td>
</tr>
<tr>
<td>Number of People Surveyed</td>
</tr>
</tbody>
</table>
Question 7 was also a Likert based response and was graded 1: being I fully agree, 2 being somewhat agree, 3 being neutral, 4 being somewhat disagree and 5: being I fully disagree. Most agencies were again nearly unanimous in their opinion that the alcohol policy while boating should be enforced, (89%). Northwest Arkansas Regional Planning Commission had the only deviances from fully agreeing. Of the agency employees that were surveyed in total 9% had different views on drinking while boating, 3% fully disagreed that drinking while boating should be enforced, 3% somewhat disagreed that it should be enforced, 3% somewhat agreed that it should be enforced and 11% fully agreed that it should be enforced.

Table 5.13  Agency Employees’ perception on whether drinking laws should be enforced while boating

<table>
<thead>
<tr>
<th>Agency</th>
<th>Fully agree</th>
<th>Somewhat</th>
<th>Neutral</th>
<th>Somewhat disagree</th>
<th>Fully disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll County</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benton County</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Planning</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Game and Fish</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Army corps of Engineers</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The last question, Question 9 “Who are the most dangerous boat drivers on Beaver Lake” Rank 1-8 (1 = most dangerous, 8 = least dangerous) was given eight options. It ranged from
adolescent females or males, you adult females or males, middle-aged (40-64) females or males, and older females or males 65+. The results as to whether men were more likely to be the cause of accidents had very similar responses. Most of the agencies fully disagreed, (19%), somewhat disagreed, (25%), or were neutral, (39%), in their answers that men were more likely to be the cause of an accident. The results from the End-of-Year Reports supplied by the Little Rock office of Game & Fish provide a more accurate calculation, and showed that in fact males are the most likely to be navigating the vessel when the accidents occur, men were involved in 82% of the accidents on Beaver Lake between 2003 to 2012.

Table 5.14 Agency Employees’ perception on whether male boat drivers are more likely to cause accidents

![Bar chart showing agency employees' perceptions on male drivers causing accidents](chart.png)

5:4 Analysis of Game & Fish Annual Reports and Survey Questions

The 2003-2011 Annual Reports from the Arkansas Game & Fish Commission provided by the Little Rock office indicated that most accidents were the result of inexperience and
inattention, which drastically counters the 58% surveyed, who speculated that alcohol was the
cause. There are also discrepancies in the annual reports in reference to the number of injuries
that actually occurred. The causes of the accidents differentiate in the survey versus the written
report included in the documentation. The tables following depict the cause and number of
accidents on Beaver Lake from 2003 - 2012 without the demographics of age, ethnicity, and
education.

Table 5.15  Game & Fish 2003 Boating Accident Report based on gender of person
navigating the vessel and day of the week

The 2003 Boating Accident Report shown in Table 15 is graphed based on the day of the
week the accident occurred, number of people that were on the vessel and the gender of the boat
navigator. There were no deaths in 2003 but there were six injuries. There were seven reported
accidents overall that year, with four out of seven where a male was navigating the boat. Three
of the seven accidents occurred on a Saturday, two of the seven occurred on a Sunday, one of the
seven occurred on a Friday, and one of the seven occurred on a Monday. Most of the accidents occurred over the weekend mainly on Saturday.

**Table 5.16** Game & Fish 2005 Accident Report based on gender and day of the week

The 2005 Boating Accident Report shown in Table 16 showed that there were no deaths that year although there were five injuries. There were eight reported accidents in 2005 and four of the eight accidents included injuries. Six of the eight accidents occurred with a male person navigating the vessel and only two of the eight accidents had a female person navigating the vessel. Six of the eight accidents occurred on a Saturday and only two of the accidents occurred on Friday. Again, the weekend showed the highest trend for boating accidents.
The 2006 Boating Accident Report was based on gender and day of the week. There were sixteen boating accidents reported that year. One of the accidents involved a death while thirteen involved injuries. Eight of the sixteen accidents occurred on a Sunday while three of the sixteen accidents occurred on a Saturday. Three of the accidents occurred during a weekday, one occurred on Tuesday and one occurred on a Wednesday. Two of the accidents occurred on a Friday. Fifteen of the accidents reported that year involved male persons navigating the boat while only one incident involved a female navigator.
In 2007 the Game & Fish Boating Accident Report had twenty boating accidents reported, one of the highest in the years that were analyzed for this study. There were no deaths that year but twelve of the accidents involved injuries. Six of the twenty accidents occurred on Friday, four occurred on Saturday, and five occurred on Sunday. One of the accidents occurred on a Thursday, two occurred on Monday, and two occurred on Wednesday. Eighteen of the twenty accidents involved a male person navigating the vessel while only two involved a female navigator.
Table 5.19  Game & Fish 2008 Boating Accident Report based on gender and day of the week

The 2008 Boating Accident Report had seven boating accidents reported for that year. There were no deaths but four injuries were recorded. Two of the accidents occurred on Saturday as well as on Friday. One accident occurred on a Sunday, one occurred on a Wednesday, and one occurred on a Tuesday. Six of the seven accidents occurred while a male person was navigating the vessel and only one occurred with a female navigator.
Table 5.20  Game & Fish 2009 Boating Accident Report based on gender and day of the week

The 2009 Boating Accident Report had nineteen reported accidents that year. One of the boating accidents involved a death while there were sixteen injuries. Seven of the nineteen accidents occurred on a Saturday while three of the sixteen occurred on a Sunday. There were two accidents that occurred on a Monday, three accidents that occurred on a Tuesday, and three accidents that occurred on a Friday of that year. Fourteen of the accidents involved a male person navigating the vessel while five of the nineteen involved a female navigator.
Table 5.21 2010 Game & Fish Accident Report based on gender and day of the week

The 2010 Boating Accident Report had the fewest accidents reported in the reports that were analyzed. There were five accidents reported that year with no deaths and two injuries. Three of the accidents reported occurred on a Sunday and two occurred on a Saturday. All the accidents that occurred in that year involved male persons navigating the vessels.
The final year that was provided by the Little Rock Game & Fish that was analyzed for this study was 2011. There were thirteen accidents reported that year. None of the accidents involved a death but seven of the thirteen accidents involved injuries. One of the accidents occurred on a Monday, one occurred on a Tuesday, one occurred on a Wednesday, one occurred on a Thursday. Most of the accidents occurred over the weekend, six of the accidents occurred on a Saturday, and two of the accidents occurred on a Sunday. Due to some data discrepancies there was another accident that was reported but the day and gender of the vessel navigator were unknown. Ten of the thirteen accidents involved a male person navigating the boat, two of the thirteen were female navigators and one unknown.
Table 5.23  Game & Fish Accident Report factors for cause of accident

<table>
<thead>
<tr>
<th>Factors Causing Accident</th>
<th>Number of People at Fault</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>5</td>
</tr>
<tr>
<td>None</td>
<td>10</td>
</tr>
<tr>
<td>Speeding</td>
<td>15</td>
</tr>
<tr>
<td>Inexperience</td>
<td>20</td>
</tr>
<tr>
<td>Inattention</td>
<td>25</td>
</tr>
<tr>
<td>Weather</td>
<td>5</td>
</tr>
<tr>
<td>Hazardous Waters</td>
<td>10</td>
</tr>
<tr>
<td>Faulty Machinery</td>
<td>15</td>
</tr>
<tr>
<td>No Lookout</td>
<td>20</td>
</tr>
<tr>
<td>Vision Impairment</td>
<td>25</td>
</tr>
<tr>
<td>Failure to Yield</td>
<td>5</td>
</tr>
</tbody>
</table>

An analysis of the Game & Fish Annual Report from 2003-2011 in Table 23 showed that the leading causes of accidents were inattention and inexperience (38%). Other factors that played a roles were speeding, weather, hazardous waters, faulty machinery, no lookout, vision impairment, and failure to yield.

5:5  Data Discrepancies

As with any analysis, there are discrepancies and inaccuracies in the study. For example discrepancies from the Annual Reports provided by the Game & Fish Commission exist, as well as inaccuracies in survey responses. Discrepancies in the surveys included: lack of answers, failure to follow instructions or written direction, or writing “No” in comment boxes rather than answering. The results in the study varied with each agency, but within each agency, answers coincided with minimal variation, especially within the Game & Fish Commission and within Carroll County Sherriff’s Department.
5:6 Cartographic Representations of Accidents

Each agency’s perception and the data from the Game & Fish Annual Reports were represented cartographically to facilitate geospatial visualization and comparison (See Figure 5-1 through 5-10). The purpose of showing the maps together is to provide perspective on the accuracy of each agency’s awareness of accidents occurring on Beaver Lake.

The Northwest Arkansas Regional Planning Commission focused most of their opinions in the Rogers and Prairie Creek campsite area. These are the locations that are nearest to each respective office.
Figure 5.1: Northwest Arkansas Commission perception map based on surveys
Figure 5.2: Game & Fish Accident Reports location of accidents based on a nine year average
Carroll County focused most of their opinions on the northern portion of Beaver Lake. It is noted that this is also the location of Carroll County patrols and headquarters and is located nearest to Eureka Springs, Arkansas.

Figure 5.3: Carroll County Sheriff’s perception on location of accidents
Figure 5.4: Game & Fish accident reports location of accidents based on a nine year average
The Army Corps of Engineers perception covered more of the lake as they are responsible for patrolling the majority of it. Their perceptions were also based off of the larger campgrounds and more populated areas which they are responsible for maintaining.

Figure 5.5: Army Corps of Engineers perception map on location of accidents
Figure 5.6: Game & Fish Accident Reports location of accidents based on a nine year average.
Bentonville’s cartographic perception focused on the southern portion of the lake, near Prairie Creek and Highway 12. Both of those areas are locations noted for more accidents in the Game & Fish Annual Report cartographic representation.

**Figure 5.7:** Bentonville Sheriff's department perception map on location of accidents
Figure 5.8: Game & Fish Accident Reports location of accidents based on a nine year average
The Game & Fish of Beaver Lake focused their cartographic perception on most of the lake. It is noted that only one of the Game & Fish officers chose the most of the locations indicated in the map.

**Figure 5.9:** Game & Fish perception map on location of accidents
Figure 5.10: Game & Fish Accident Reports location of accidents based on a nine year average
CHAPTER 6
CONCLUSION and IMPLICATIONS

Beaver Lake was impounded 48 years ago (2014), and has provided recreational activities every year since. It has also had a long history of accidents and deaths even with the technological advancements and rigorous patrols. However, further research is needed for a better understanding of the gap between perception of accidents and causes and statistics.

Figure 6.1: Army Corps of Engineers use of “Wear It” campaign (USACE, 2014).

The objective of this study was important because although Beaver Lake is patrolled, it was necessary determine the perceived knowledge of the agencies to accident locations in comparison to the reality of accidents on or near the lake. Despite the number of acceptable surveys at only thirty-six, the findings are vital since it divulged the perceptions of those agency officials involved with effective policy-making. The results divulged the awareness of risk awareness of agency employees regarding accidents on Beaver Lake and their knowledge of
accidents and their location compared with annual reports of accidents. Assessing the awareness of accidents and the perception gap as perceived by the local and federal agency employees may create a consciousness regarding accidents on Beaver Lake. One hundred and eighteen deaths have occurred on or at Beaver Lake since its formation in the last forty years (USACE, 2014). The surveys indicated that a spatial bias existed depending on the agency; Carroll County Sheriff’s Department was more familiar with the Northern portion of the lake (Figure 5-3), as that is where they patrol and is their first responsibility. Game & Fishes surveyed data was focused on all of Beaver Lake (Figure 5-9). Accidents do occur all over Beaver Lake, but there were trends showing that most accidents occurred in the Rogers area or near the Highway 12 Bridge (Figure 5-2). Overall, it does appear that local and federal agencies have a clear knowledge of the accidents on Beaver Lake when compared to Lake of the Ozarks, which is the third most deadly lake in the United States and is only two hundred miles away (Ozarks First, 2014). The findings from the survey are summarized below:

**Perceptions of Agency Employees Surveyed**

- 44% of agency employees thought men were less likely to be the cause of accidents
- 39% of agency employees neither agreed or disagreed that men were more likely to cause boating accidents
- 50% of agency employees considered alcohol to be the leading cause of accidents
- 89% of agency employees believed that the alcohol policy should be enforced on Beaver Lake
- 50% of agency employees considered water safety to be excellent on Beaver Lake
- 27% of agency employees considered water safety on Beaver Lake to be neither excellent or poor on Beaver Lake
- 25% of agency employees considered that most accidents were located at Prairie Creek
The importance of relating the agency employees perception to the study is to find any gaps that may be helpful in the prevention of future accidents, injuries, and death. The finding showed gaps in the perceived gender of the boat navigator, men were more likely to be navigating the vessel than females. The perception for cause of accident was alcohol but the Annual Boating Accident Reports showed that inattention and inexperience were the leading causes. If alcohol has a higher rate for the cause of accidents then further studies should be administered to prove that as there was not enough documentation proving that information. These findings can also show flaws in the study and with agency perception that can be viable for future studies to improve upon and therefore improve the water safety on Beaver Lake.

Safety is a constant concern for Beaver Lake as there have been 118 total deaths on Beaver Lake since 1966, when the reservoir was impounded (USACE, 2014). Of the deaths, 106 were caused by drowning; the other deaths were due to explosions, heart attacks, strokes, and other causes. The results of the data are most helpful in implying that carelessness and inattentiveness of those on Beaver Lake are causing the most accidents. While alcohol was not an abundant cause in most of the results, it should not be ruled out as a cause. These data provide support that monitoring boating licenses, improving public awareness, providing seminars for boating protocol, and even renewal of licenses could help in decreasing the mishaps. The 2012 End of Year Reports for Game & Fish Arkansas showed that boaters with roughly 500 hours of experience were as likely to cause accidents as those with less than 20 hours of experience. Treating boating accidents and intoxication as law enforcement treats DUIs on roadways could make improvements for safety on waterways. Rather than simply citing and fining the offender, add the punishment of losing one’s boating license could provide incentive for more careful conduct on lakes. In many of the written discussions of the accident reports, the perpetrators left
the scene and returned the next day, speculation by the officer provides insight that they were probably left and returned later so that they were more sober. Overall, Beaver Lake is an area that provides ample data for scientific study, and the results could be enlightening for everyone concerned.

There are many factors that coincide to keep waterbodies safe areas. Having the knowledge of previous accident causes can help anticipate future accidents. Research of this nature is very important because of the evaluation of hazardous activities and the judgments made by the public (Slovic, 2000). Slovic, who created Decision Research, understood the importance of risk perception through the use of the public’s perception. Since then risk perception research has been used in numerous fields, an example is Heggie’s research which has been vital for the National Parks System, and would greatly benefit Beaver Lake and other

Figure 6.2: United States Coast Guard “Wear It” (USCG, 2014).
waterbodies. With more awareness millions of dollars and lives can be saved through risk perception research, even the smallest piece of survey data can provide more information than no piece at all (Paradise, 2006).

After conducting the Beaver Lake survey, the findings suggest that changes can still be implemented to improve the quality of safety on the lake. Suggestions are listed below:

**Recommendations for accident mitigation on Beaver Lake**

- *Add Lake of the Ozarks, Bull Shoals Lake, and Norfolk Lake to survey for more perspectives on lake safety*

- *Add marinas, local volunteer agencies, and civilians to the survey for a broader demographic*

- *All surveys be printed in both English and Spanish to reach a wider demographic*

- *Contact local newspapers and media run safety guidelines for visitors on lakes during warmer months to improve safety awareness*

- *Obtain further documentation on accidents from local police departments and local emergency response that are liable for emergency calls*

This study of Beaver Lake risk perception is a baseline study that can facilitate more research into lake hazards in the region and across the U.S. Such research can lead to the creation of strong policies that will save lives, decrease human risk and injuries as well as financial losses with the assessment of the hazardous activities on Beaver Lake. Studies that assess the risk analysis can lead to better policy-making, provide a better understanding of the public’s views on hazards, and help regulate the overall safety of the community which was the purpose and goal of this research (Slovic, 2000).
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Appendix A

Beaver Lake Risk Assessment Survey
University of Arkansas Risk Assessment Survey

Beaver Lake Risk Assessment

Have you been in an accident on Beaver Lake?  □ NO  □ YES  □ Witnessed one?  □ Never witnessed one?

AGE (YEARS):  □<20  □ 20-30  □ 31-40  □ 41-50  □ 51-60  □ 61-70  □ 71 or more  □ SEX:  □ M  □ F

BIRTHPLACE:  □ in a city  □ in a town  □ in a rural area  Where? ______________________(town, county, state)

EDUCATION:  □ no school  □ some school  □ high school  □ some college □ college □ grad college

INCOME:  □ <$20,000  □ $20,000-34,999  □ $35,000-49,999  □ $50,000-64,999  □ $65,000-$80,000  □ >$100,000

• When did the last accident occur that you know about?
  □ this month  □ last month  □ this year  □ last year  □ none of the above  □

• What do you believe was the cause of the accident?
  □ alcohol □ dehydration □ texting □ lack of education □ all of these □ none of these, explain: __________________________

• Where do you believe most of the accidents occur?
  □ Prairie Creek  □ Indian Creek  □ Rocky Branch  □ War Eagle  □ Lost Bridges  □ Horseshoe Bend
  □ Middle of the lake  □ North portion of Beaver Lake  □ South portion of Beaver Lake □ other (explain below)

• What do you consider to be the primary influence on poor water safety on Beaver Lake?
  □ alcohol □ dehydration □ texting □ lack of education □ all of these □ none of these, explain: __________________________

• At what age should a boating license be granted? ___________ years

• Water safety on beaver lake is excellent

• Drinking while boating policies should be enforced

• Male boat drivers are least likely to cause a boating accident

• Who are the most dangerous boat drivers on Beaver Lake? Rank from 1-8 (1 = most dangerous, 8 = least dangerous)
  □ Older male 65+  □ Young adult male 20-39  □ Middle-age male 40-64  □ Adolescent male 16-19
  □ Older female 65+  □ Young adult female 20-39  □ Middle-age female 40-64  □ Adolescent female 16-19

Comments (regarding the ranking above): ________________________________________________________________
Place an 'X' on the map to show your perception of where Beaver Lake incidents occur:

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Comments:

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Appendix B

Images of Arkansas and Beaver Lake
Appendix B:1 Monument to for those who suffered in the flood of 1927 (Pris, 2005).

Appendix B:2 Flood of 1927 ripped off half of the Baring Cross Bridge in Pulaski County, AR (Encyclopedia of Arkansas, 2014).
Appendix B:3 All floodgates open at Beaver Lake Dam (USACE, 2014).

Appendix B:4 Beaver Lake Watershed Alliance sign and awareness campaign (USACE, 2014).
Appendix B:5 Construction of Beaver Lake Dam (USACE, 2014).

Appendix B:6 Construction of Beaver Lake Dam (USACE, 2014).
Appendix B:7 Construction of Beaver Lake Dam (USACE, 2014).

Appendix B:8 Nimrod dam part of the Flood Control Act of 1938, shows another process Beaver Lake Dam would have undergone during construction (USACE, 2014).
Appendix B:9 Beaver Lake Dam nearing finish (USACE, 2014).

Appendix B:10 Beaver Lake Dam nearing completion (USACE, 2014).
Appendix B:11 Warning signs near Beaver Lake Dam regarding flooding (USACE, 2014).

Appendix B:12 The amphitheater at Monte Ne (Encyclopedia of Arkansas, 2014).
Appendix B:13 Monte Ne amphitheater before Beaver Lake was created (Rogers Historical Museum, 2008).

Appendix B:14 Map of locations of Harvey Coin’s Monte Ne (Rogers Historical Museum, 2008).
Appendix B:15 Remote Sensed image of Arkansas (Paradise, 2010)

Appendix B:16 Hydro map of Arkansas (Paradise, 2010)
Appendix B:17 Elevations of Arkansas (Paradise, 2010)

Appendix B:18 Precipitation in inches across the state of Arkansas (Paradise, 2010)
Appendix B:19 Temperature ranges from coldest to warmest across Arkansas (Paradise, 2010)

Appendix B:20 Geologic Map of Arkansas (Paradise, 2010)
Appendix B:21 CDC Rates of drowning in the United States (CDC, 2012).

Appendix B:22 Rates of drowning by the CDC based on race (CDC, 2012).
September 25, 2013

MEMORANDUM

TO: Laura Ahrens
    T.R. Paradise

FROM: Ro Windwalker
      IRB Coordinator

RE: New Protocol Approval

IRB Protocol #: 13-09-108

Protocol Title: Perception Assessment of Risk and Safety on Beaver Lake, Northwest Arkansas

Review Type: ☑ EXEMPT ☐ EXPEDITED ☐ FULL IRB

Approved Project Period: Start Date: 09/25/2013  Expiration Date: 09/24/2014

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form Continuing Review for IRB Approved Projects, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (http://vpr/red.uark.edu/210.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 150 participants. If you wish to make any modifications in the approved protocol, including enrolling more than this number, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.