



Beaver Lake Boating Carrying Capacity Study



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Appendices

Appendix A Boating Carrying Capacity Studies: A Literature Review

Appendix B Boater Survey Report

Appendix C WALROS Classification of Beaver Lake

Appendix D Field Survey Methodology

Acronyms

| | |
|-------------|--|
| ANS | Aquatic Nuisance Species |
| BOATS | Total boats actively operating on the available water surface at any given point in time |
| FY | fiscal year |
| GIS | geographic information system |
| MP | Master Plan |
| MSA | Metropolitan Statistical Area |
| NWARPC | Northwest Arkansas Regional Planning Commission |
| OMB | U.S. Office of Management and Budget |
| OMBIL | Operations and Maintenance Business Information Link |
| Reclamation | U.S. Bureau of Reclamation |
| SMP | Shoreline Management Plan |
| USACE | U.S. Army Corps of Engineers |
| WALROS | Water and Land Recreation Opportunity Spectrum |

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Executive Summary

During the summer of 2016, a recreational boating carrying capacity study was completed on Beaver Lake, Arkansas for the Little Rock District of the U.S. Army Corps of Engineers (USACE). This study characterizes current boating lake use during peak boating periods and boaters' perspectives on safety and crowding at the lake. The primary focus of the study is to evaluate existing recreational use and users' perspectives against carrying capacity ranges researched and developed specifically for the Beaver Lake setting. Additional information regarding facility carrying capacity was collected and is also presented to assist in future lake management decisions.

For study purposes, Beaver Lake was delineated into five study zones. Data were collected, analyzed and are reported according to study zone and the lake as a whole, as appropriate. The surface area of the lake useable for boating was calculated by study zone, providing the basis for estimating current boat density (useable acres per boat) (**Figure ES-1**).

Field data were collected on recreational boating lake use during four high-use summer weekends. Data were collected through aerial boat counts and simultaneous ground counts of empty boat trailers and empty marina slips. This information was utilized to determine the number and types of boats using the lake at any given time. The collected information also provides insights into boat origin and existing utilization levels of lake access facilities and infrastructure during peak times.

A survey of boaters at Beaver Lake was conducted following the summer boating period in 2016 and provides information on user characteristics, on-water activities, and perceptions of safety, crowding, and preferred boat density. This information was used to develop an acceptable range of social boating carrying capacity at Beaver Lake and to assess the impact of existing boating density on the quality of the recreational experience and boating safety. According to federal guidelines and requirements, the survey questionnaire was approved by the U.S. Office of Management and Budget (OMB) prior to its administration. The survey had a response rate of 45 percent and provided a statistically valid sample for the analysis.

To provide the context and setting for interpretation of the results, the lake and surrounding area were characterized with input from the USACE Beaver Lake Project Office management staff and Chief Rangers as well as data collected from various sources. A literature review was completed to identify nationwide studies of similar nature with established carrying capacity benchmarks. Data collected for the study included existing Beaver Lake reports, boating incident and fatality data for Beaver Lake and other recreational lakes in Arkansas, visitation data, area demographics, an assessment of existing infrastructure, and a lake characterization following the Water and Land Recreation Opportunity Spectrum (WALROS) developed by the U.S. Bureau of Reclamation (Reclamation).

An overview of the study process is shown in **Figure ES-2**.

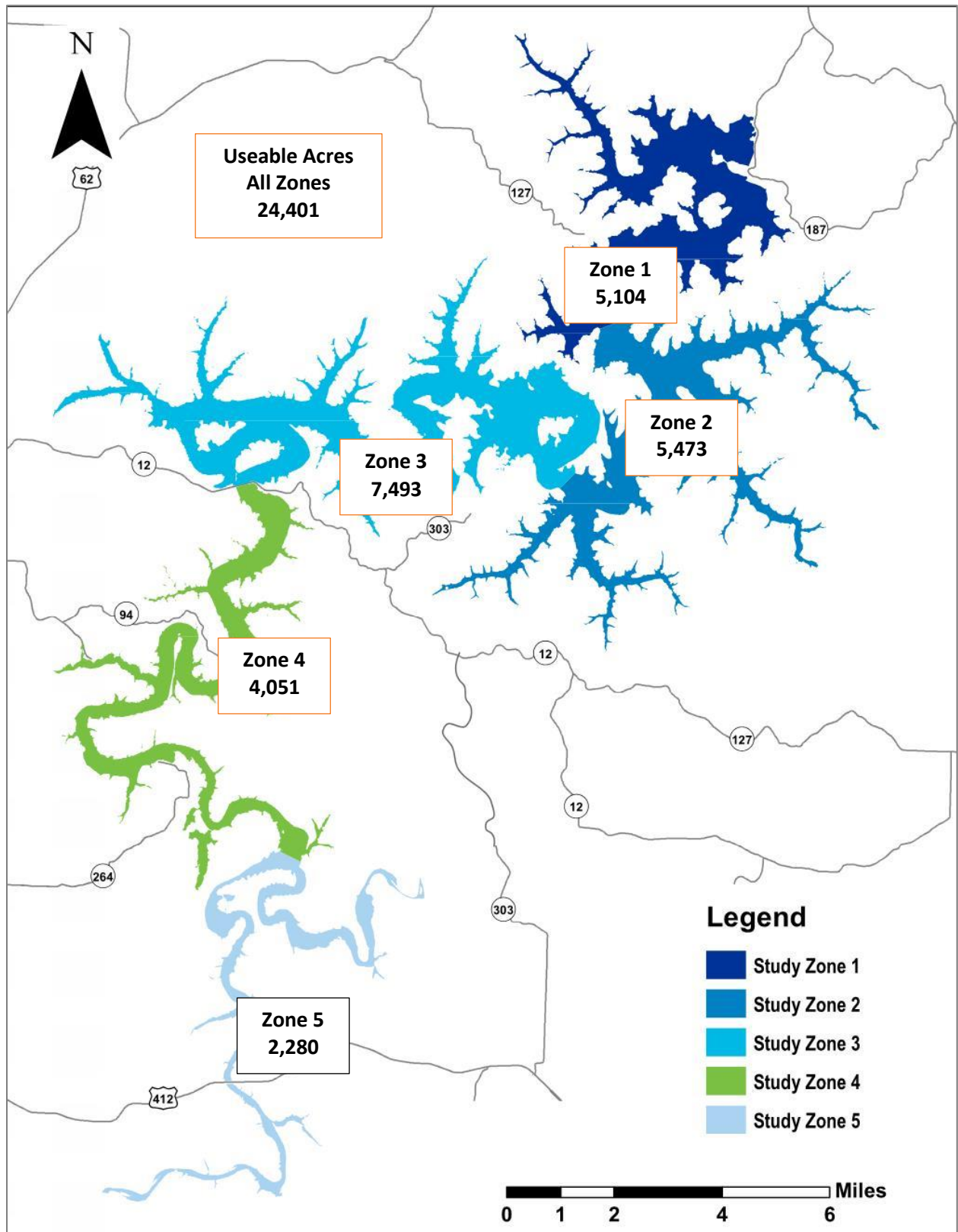


Figure ES-1. Lake Study Zones and Useable Surface Area

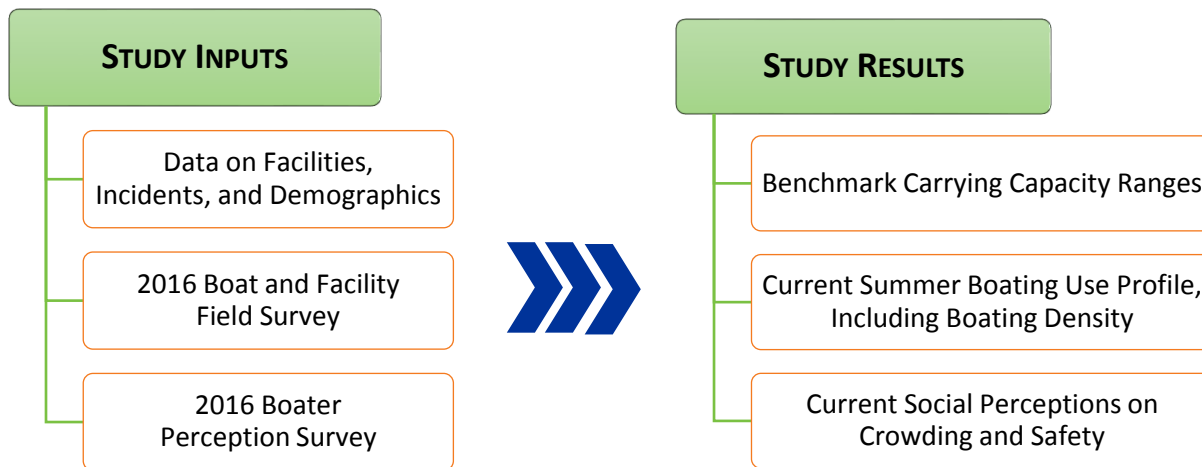


Figure ES-2. Beaver Lake Recreational Carrying Capacity Process Overview

ES.1 Setting the Carrying Capacity Benchmarks

An essential component of the carrying capacity study is the calculation of benchmark ranges of appropriate boating carrying capacity specific to each study zone of Beaver Lake. Shoreline configuration, lake setting and context, visitors’ perceptions, number of accidents involving other boats, boat type and speed, and dominant boating activities were factors specific to Beaver Lake that were taken into consideration in determining a range of appropriate boat densities.

WALROS was used to incorporate lake managers’ and experts’ perceptions of the physical, social, and managerial attributes of each study zone to develop an appropriate range of recreational boating capacities or densities. The WALROS methodology allows users to classify a specific lake into a spectrum that ranges from urban, suburban, rural developed, rural natural, semi-primitive, and primitive recreation opportunities. The lake was classified overall as “*Suburban*” with an associated broad boating capacity range of 10 to 20 useable water surface acres per boat.

To arrive at a more precise boating capacity range by study zone, the WALROS Range Decision Tool was utilized to incorporate additional information for each study zone and to narrow down the recommended range of densities. This additional analysis resulted in the recommended carrying capacity range of approximately 14 to 17 useable acres per boat in Zones 1, 2, and 4; 18 to 20 useable acres per boat in Zone 3; and 10 to 13 useable acres per boat in Zone 5 (**Table ES-1**).

Table ES-1. Recommended Carrying Capacity Range for Beaver Lake by Study Zone

| Study Zone | Capacity Range (useable acres per boat) |
|-------------|--|
| Entire Lake | 10–20 |
| Zone 1 | 14–17 |
| Zone 2 | 14–17 |
| Zone 3 | 18–20 |
| Zone 4 | 14–17 |
| Zone 5 | 10–13 |

To validate and confirm the carrying capacity ranges from the WALROS method, a literature review was conducted to develop capacity ranges considering only the spatial carrying capacity for Beaver Lake. Shoreline configuration, useable lake area, dominant boat types and speed, and historical crowding-related accident records were considered in conjunction with past studies. Based on these considerations, a conservative spatial boating carrying capacity for Beaver Lake was determined to be 10 to 20 acres per boat. The range of carrying capacity is dependent on boat type and study zone, thereby confirming the WALROS range.

Similarly, social carrying capacity benchmarks were developed to validate the WALROS range based on users' perceptions of crowding from the boater perception survey. Using photo simulations, survey respondents were asked to indicate which photograph represents the maximum number of boaters one could see at a time without thinking it was too crowded. Based on calculated boat densities associated with each photo, 88 percent of boaters indicated a preference for boating densities that do not exceed 10 acres per boat. Furthermore, density that reaches 14 acres per boat exceeds the preference of 55 percent of boaters. The reported optimal boating preferences of the survey respondents are provided in **Figure ES-3**.

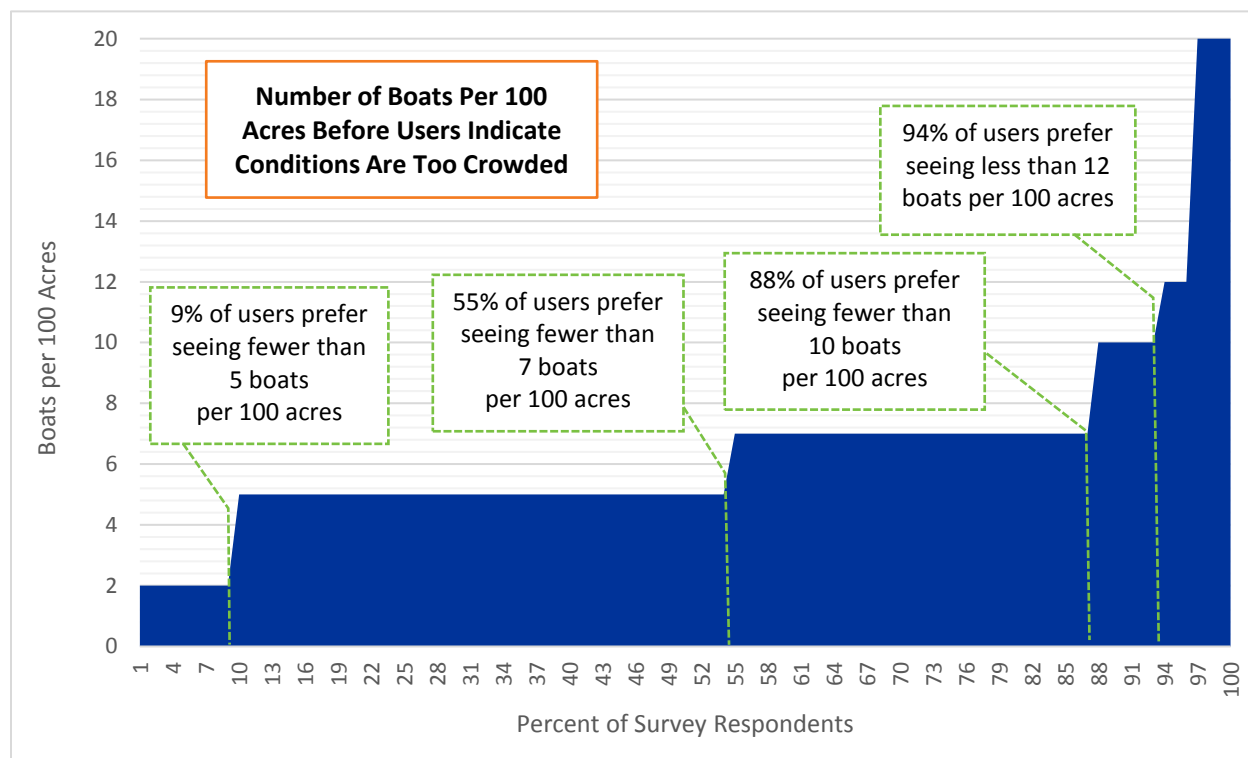


Figure ES-3. Survey Respondent Optimal Social Boat Density

ES.2 User Perceptions on Safety and Crowding

Most respondents to the boater survey indicated that they feel boating conditions on Beaver Lake are very to extremely safe (64 percent) while the remaining 36 percent noted some concern for boating safety. The top boating safety concerns are summarized in **Figure ES-4**. Six out of 10 respondents

indicated that the number of boats on Beaver Lake is creating some degree of a safety problem (**Figure ES-5**). Results indicate that boaters who primarily recreate in Zones 3 or 4 are slightly more likely to note safety issues than those that use Zones 1, 2, or 5.

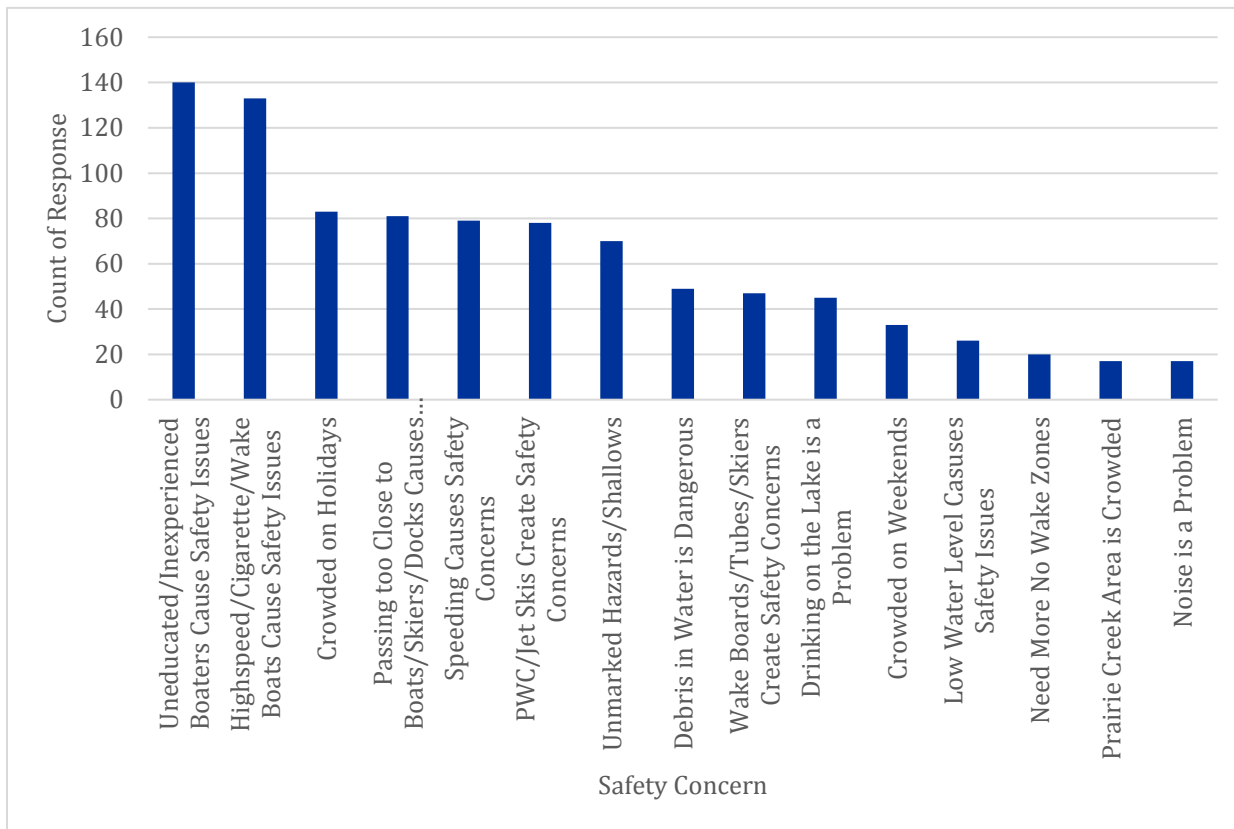


Figure ES-4. Top Boating Safety Concerns

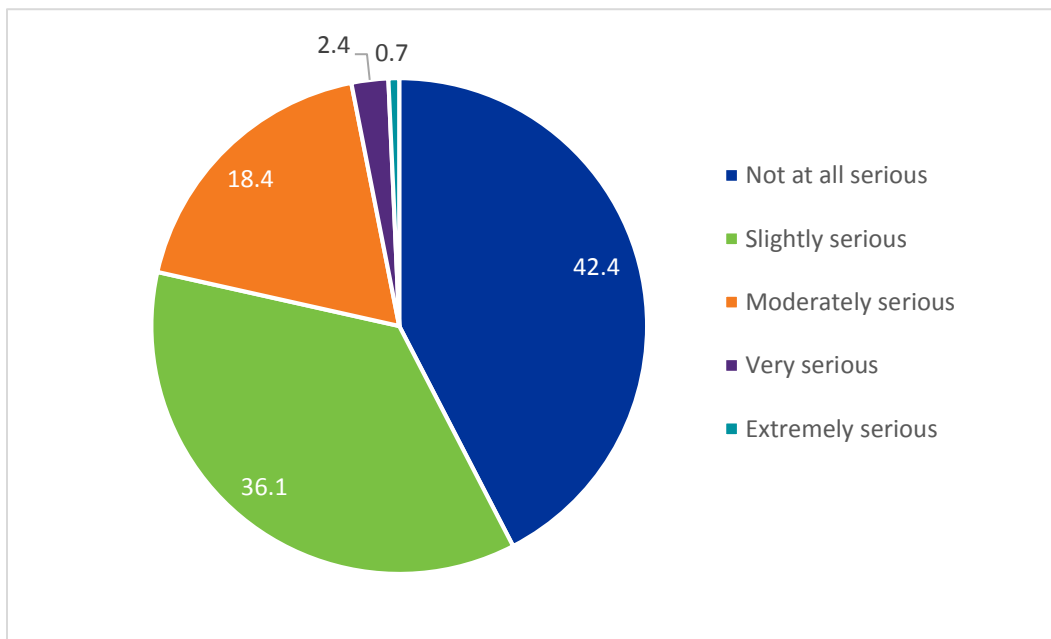


Figure ES-5. Seriousness of a Safety Problem from the Number of Boats

One out of 4 respondents indicated that they feel there is a problem with too many boats on Beaver Lake. Those that use rowboats, kayaks, or canoes were more likely to see a problem of too many boats, followed by boaters using fishing or bass boats. Only slight variations exist in users' perceptions of crowding based on the zone primarily used during an average boating trip. Boaters indicated that they are responsive to crowding and will change their behavior if the social carrying capacity at Beaver Lake is exceeded.

ES.3 Current Boat Use and Origination

To establish the current (2016) summer recreational boating use profile for Beaver Lake, a field survey was conducted consisting of coordinated aerial and ground surveys. During aerial flyovers, observers recorded the number and type of boat and recreational activity while noting approximate locations of each boat on map sheets. Boats were tallied by type and activity, according to the list below.

Power Boats and Activities

- Fishing/Bass
- Pontoon/Houseboat
- Skiing/Wake
- Speedboat
- Personal Watercraft

Non-Power Boats and Activities

- Sailboat
- Canoe/Kayak

Simultaneously, ground crews surveyed the number of empty boat trailers at public boat ramps and campgrounds. Similarly, the number of rented but empty boat slips at each marina was tallied. Counts were conducted in the morning and the afternoon on both Saturday and Sunday of four summer weekends (including the Fourth of July and Labor Day holiday weekends) during the 2016 recreation season. Two survey periods were called off due to weather and crew safety concerns thus field data were collected for a total of 14 observations.

The greatest number of boats counted during any survey period was during the Labor Day weekend on the afternoon of September 4, 2016 when 1,450 boats were observed on the lake at one time ("BOATS"). The observed peak boating density for Beaver Lake is calculated by dividing the usable water surface acres by the boat count from the survey period that tallied the most number of boats:

$$\text{Observed Peak Boat Density} = 24,401 \text{ useable acres} \div 1,450 \text{ boats} = 16.8 \text{ acres/boat}$$

The analysis of boat density was completed for each of five study zones. **Table ES-2** provides the observed maximum boat density for each study zone. Higher density values are reflective of fewer boats

on the lake. Zone 2 was found to have the greatest density of boats at 12 acres per boat followed by Zone 4 at 15.5 acres per boat.

Table ES-2. Observed Boat Density by Study Zone

| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Total |
|-------------------------------|--------|--------|--------|--------|--------|--------|
| Useable Acres | 5,104 | 5,473 | 7,493 | 4,051 | 2,280 | 24,401 |
| Maximum Number Observed Boats | 297 | 455 | 394 | 261 | 68 | 1,450 |
| Useable Acres per Boat | 17.2 | 12.0 | 19.0 | 15.5 | 33.5 | 16.8 |

There are notable differences in use patterns across lake zones and by time of day. Consistently fewer boats were observed on the water in the morning survey periods, and the areas where boaters concentrate also varied considerably between the morning and afternoon counts. Boat type/activity varied by lake zone and between the morning and afternoon counts, with fishing boats more frequently encountered in the mornings in Zones 4 and 5 and waterski boats more common in the afternoons in Zones 2 and 3.

Field data are also used to estimate the origination facility for boats on the water. Counts of empty boat trailers and empty marina slips are used to derive the percentage of boats originating from public boat ramps, marinas, and private, community, and resort boat docks. The field data indicate that approximately 42 percent of the boats on the water originate from public boat ramps, 43 percent from marina slips, and 15 percent from private, community docks, and resort docks (**Figure ES-6**).

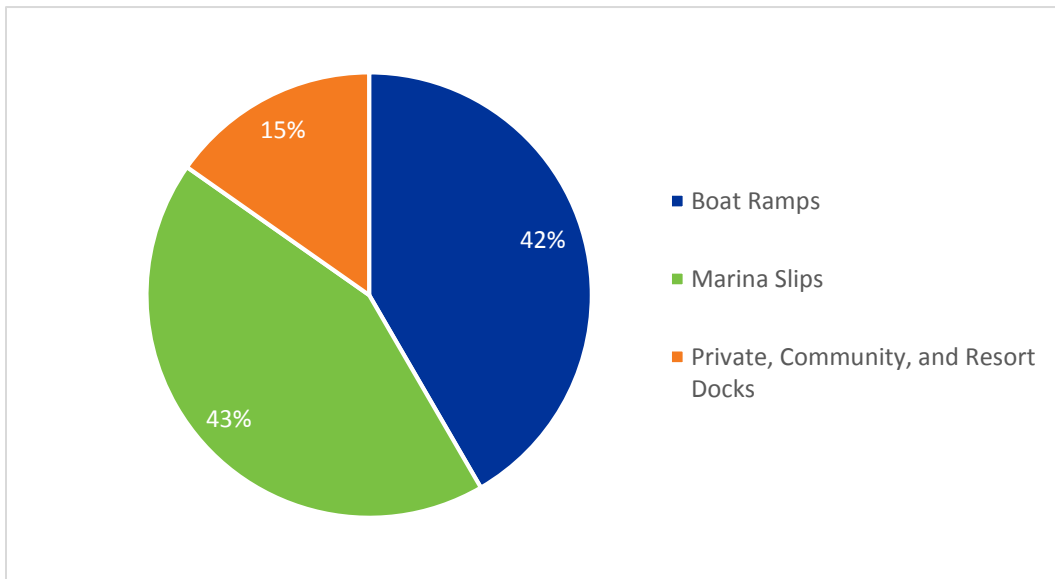


Figure ES-6. Average Boat Origination by Facility Type

ES.4 Analysis of Current to Potential Capacity

Given the recommended lake-wide range of 10 to 20 acres per boat developed using the WALROS methodology and the *Observed Peak Boat Density* of 16.8 useable acres per boat, Beaver Lake has

currently reached but not exceeded the recommended carrying capacity during peak use times (**Figure ES-7**). The density of 20 and 10 useable acres per boat translates to approximately 1,410 and 1,689 BOATS, respectively. This translates to a capacity utilization ranging from 86 to 103 percent.

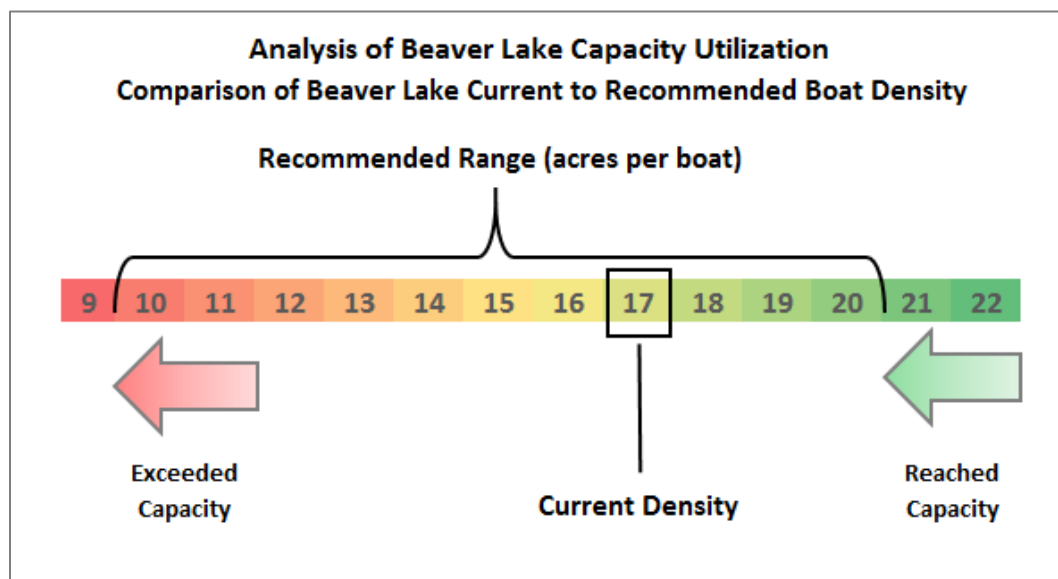


Figure ES-7. Beaver Lake Carrying Capacity Utilization

The analysis of capacity utilization can be further assessed by study zone. As shown in **Table ES-3**, Zones 1, 3, and 4 peak boating densities indicate boating activities have reached but not exceeded the recommended ranges of carrying capacity. Zone 2 exceeds the suggested benchmark carrying capacity range, with an estimated peak density of 12 acres per boat compared to a suggested carrying capacity range of 14 to 17 acres per boat. Zone 5 was found to be underutilized, with an estimated peak summer density of 34 acres per boat.

Table ES-3. Summary of Beaver Lake Carrying Capacity Utilization by Study Zone

| Study Zone | Dominant Boat Type | Crowding Concerns (% indicating too many boats) | Safety Concerns (% indicating less than very safe) | Observed Maximum Boat Density (acres per boat) | WALROS Carrying Capacity (acres per boat) | Analysis of Capacity Utilized |
|------------|--------------------|---|--|--|---|-------------------------------|
| Zone 1 | Ski/Wake | 20 | 26 | 17 | 14 to 17 | Reached |
| Zone 2 | Ski/Wake | 27 | 36 | 12 | 14 to 17 | Exceeded |
| Zone 3 | Ski/Wake | 25 | 40 | 19 | 18 to 20 | Reached |
| Zone 4 | Pontoon | 21 | 40 | 16 | 14 to 17 | Reached |
| Zone 5 | Fish/Bass | 31 | 36 | 34 | 10 to 13 | Not Reached |

Additional analyses were conducted to determine the relationship between *BOATS*, existing facilities, and boat origination. *Total Access Opportunities* is a measure of the total number of boats that can be

moored or stored at an approved moorage facility, such as a marina or boat dock, plus the total number of boats that can be placed on the water surface using an approved boat ramp or launch facility. Currently, the *Total Access Opportunities* for Beaver Lake is 7,843 boats.

Facility Use Rate is a measure of the estimated number of boats on the lake at any given time from the access points. *Facility Use Rate* is calculated by dividing the *Total Access Opportunities* by *BOATS*. Currently, the *Facility Use Rate* for Beaver Lake is 19 percent. The *Facility Impact Rate* furthers this calculation and indicates a 5:1 ratio of access opportunities to *BOATS*. In other words, at Beaver Lake, adding 5 access opportunities results in 1 additional boat on the water during peak times.

It is possible to estimate the *Facility Use Rate* and thus the *Facility Impact Rate* by facility type:

- *Marina Facility Impact Rate* = 4:1
- *Boat Ramp Facility Impact Rate* = 1:1
- *Private, Community, and Resort Dock Slips Facility Impact Rate* = 14:1

ES.5 Discussion

The recommended boat density from WALROS and other studies is similar to the densities the majority of survey respondents selected as the point beyond which the lake would be too crowded. Because Beaver Lake is currently within the recommended boating density, and only exceeds it in limited areas or for limited periods of time, it is not surprising that more survey respondents did not rank current crowding as a significant issue. However, there is evidence that boaters are beginning to experience negative consequences. One in 3 survey respondents did note at least some level of concern regarding boating safety, and 58 percent indicated that they feel that the number of boats on Beaver Lake is creating a safety problem. Comments received during the 2015 and 2016 Master Plan (MP) and Shoreline Management Plan (SMP) scoping processes for Beaver Lake indicated a desire for greater boater safety through the regulation of boat size/type and speed, increased enforcement of rules, or increased patrols. Zone 2 exceeded recommended capacity during the study period and has seen 5 times more crowding-related incidents over the past 6 years than Zones 1 or 4. Zone 2 is known to lake management as having several “party cove” areas in which several boats will tie together in a cove. These areas were verified during helicopter flyovers and contribute to the high *BOATS* estimates observed within this zone. While a gathering of stationary boats in coves generally does not contribute to a lake-wide crowding issue or an increase in the frequency of accidents, it can contribute to crowding and accidents as boats return to their point of origin.

Given that the Northwest Arkansas Regional Planning Commission (NWARPC) projects the population of Springdale, Bentonville, Bella Vista, Lowell, and Centerton will more than double from 2015 to 2035, the demand for recreational boating opportunities at Beaver Lake is likely to increase. The public boat ramp facilities are currently experiencing a 1:1 *Facility Impact Rate*. However, only 7 percent of the existing private, community, and resort boat dock slip owners are currently boating at one time. Given the large number of these boat slips on Beaver Lake, even minor changes to this use pattern can impact the number of boats on the water at any given point in time. From this information, lake managers can better plan for the future of Beaver Lake and strive for a healthy, balanced level of recreational boating.

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Section 1

Introduction

Located in the Ozark Mountains of northwest Arkansas, Beaver Lake is a popular attraction for nature lovers and water enthusiasts during all seasons but especially so in the summer. Its recreational amenities, scenery, and clear water coupled with its location near one of the fastest growing metropolitan areas in the United States makes it a prime destination for a multitude of recreational boating activities. Increases in lake visitation along with regional population growth have raised crowding-related concerns among lake managers and visitors. As a result, lake managers have been tasked with identifying a range of recreational boating use levels at Beaver Lake that address environmental protection goals while also preserving users' recreational experiences. The purpose of this study was to collect data on boating use of Beaver Lake and to develop a range of recommended boating carrying capacities to assist lake managers with meeting demands on lake resources.

The Little Rock District of the U.S. Army Corps of Engineers (USACE) is the steward of the lands and waters around Beaver Lake and is responsible for providing the public with quality outdoor recreation experiences that serve the needs of present and future generations. Beaver Lake is formed from the headwaters of the White River and is popular with boaters, campers, fishermen, and scuba divers. The lake is a manmade reservoir authorized by the Flood Control Act of 1954. Construction of Beaver Dam, on the northeastern side of the lake, was completed in 1966. The lake has 490 miles of natural shoreline and 28,299 acres of surface water. Not only is it a great source of outdoor recreation, but it is also the largest supplier of water to northwest Arkansas, serving over 400,000 customers. **Figure 1-1** shows an aerial view of a portion of the lake on a busy Sunday afternoon (Labor Day weekend 2016).



Figure 1-1. Beaver Lake, September 4, 2016

1.1 Study Purpose

The purpose of this Beaver Lake boating carrying capacity study was to gather information, using statistical methods, about recreational boating use on Beaver Lake and the perceptions/preferences of boaters concerning management of the lake. USACE is currently in the process of updating Beaver Lake's Master Plan (MP) and Shoreline Management Plan (SMP). This carrying capacity study is intended to provide data to support these plan revisions by:

- Evaluating the impact current lake usage has on the quality of recreation and public safety
- Evaluating the effect that marinas, boat ramps, private boat docks, and commercial activities have on the carrying capacity and distribution of users on the lake
- Evaluating boater's perceptions of resource, social, and management conditions at the lake
- Estimating the carrying capacity of Beaver Lake, expressed as a benchmark range of recommended boat densities specific to Beaver Lake and for differing geographic areas of the lake (as appropriate), and assessing how much of that capacity has been reached under existing conditions

A level of use that balances environmental protection and user enjoyment may be considered an optimal recreational carrying capacity (U.S. Bureau of Outdoor Recreation 1977). Boating carrying capacity is defined to include consideration of both the number and types of watercraft on the lake.

1.2 Carrying Capacity Definitions

The overall goals and objectives of a carrying capacity study are specific to the lake being studied. Some carrying capacity studies are focused solely on one aspect of carrying capacity, such as recreational safety, while others provide a comprehensive view of the elements that may affect boating carrying capacity. Studies are typically designed with the aim of informing management strategies to balance the recreational uses of the lake while protecting the boating environment. The resulting overall recommended carrying capacity is specific to the lake being studied and may be derived using one or a combination of several methodologies.

In reviewing past studies, it was determined that there are four main types of recreational carrying capacity (ERM, Inc. 2004, Olvany and Pitchford 2010, Colorado State Parks 2011). Recreational boating carrying capacity can be identified using any combination of these four indicators, depending on the overall goals and management objectives of the project. The four components are ecological, facility, spatial, and social carrying capacity. See Appendix A for the complete literature review.

Ecological carrying capacity refers to the ability of the ecosystem to cope with human impacts associated with recreational activities. These would include impacts on wetlands and riparian communities, trash accumulation and pollution, soil erosion and shoreline damages, and loss of groundcover. Ecological carrying capacity may also include impacts on cultural resources at developed and dispersed recreation areas.

Ecological carrying capacity can be one of the most difficult indicators to quantify. For some ecological indicators, the presence of a single boat can be as disturbing as many boats, depending on the activity

(Colorado State Parks 2011). Impacts on the natural environment from major disturbances can be measured and may be either short- or long-term. Impacts may include shoreline erosion or damage, a significant drop in waterfowl rafting, damage to vegetation, loss of fish and wildlife habitat, destruction of fish spawning and rearing areas, deterioration of water quality, increased trash or pollution, and/or dispersal of invasive plant species (Olvany and Pitchford 2010, Rajan et al. 2011). Water quality related impacts, including pollution and increases in turbidity, can be measured through establishment of a long-term surface water sampling plan. Other impacts, such as shoreline erosion and vegetative damage, may take several years of field observations to document trends. Ecological impacts can also be qualitatively measured through user survey questions aimed at perceptions of water clarity and quality and/or shoreline property owners' perceptions of shoreline damage and erosion.

Facility carrying capacity refers to the ability of the recreational facilities to accommodate the number of users. Facilities may include parking lots (boat trailer and vehicle parking), marina slips, boat launches, and other day use sites. Analysis of this component may include metrics such as wait times to use facilities or parking space vacancy rates.

Facility carrying capacity is dependent on the size of available facilities and metrics such as boat launch procedures for each lake. In a study at Stagecoach State Park in Colorado, estimates of facility capacity included an evaluation of wait times to complete Aquatic Nuisance Species (ANS) inspections prior to boat launch (Colorado State Parks 2011). Reservoirs that do not require inspections could derive launch wait time estimates from monitoring and recording boat launch waits during several peak times. Estimates of facility capacity may also include field counts of available boat trailer and vehicle parking spaces and/or available marina slip rentals during peak boating periods (CDM Smith 2012).

Facility carrying capacity can be used as a limiting factor to manage recreational access and achieve boating carrying capacity goals (Colorado State Parks 2011). For example, it may be possible to influence actual boat density by managing the facility capacity and thus meet spatial carrying capacity goals.

Spatial carrying capacity refers to physical constraints of the lake related to its size and the useable surface water area for various types of boating activities. Spatial carrying capacity is the number of boats that can comfortably engage in their chosen recreational activity within a specific area of the lake. Spatial boating carrying capacity considers the useable acres of the lake, the boat types, peak use levels, and how the lake is being used.

Techniques used to estimate the total number of boats in use during peak and non-peak times may include on-the-water surveying, aerial fly-overs, and/or parking lot vehicle counts (Bosley 2005). Field data collection of boat density on smaller lakes may include scanning the water with binoculars from various vantage points along the shoreline (Lake Ripley Management District 2003) or boat surveys of open water and shorelines (Cherokee CRC 2010, JFNEW 2007). Larger lakes may require fixed wing or helicopter flyovers (JFNew 2007, Pinecrest Lake 2012, CDM Smith 2012) or the use of aerial photography (ERM, Inc. 2004). In some cases, aerial photography can be used to validate the findings of on-water or aerial observations. Boat count and boat type data can also be collected during field surveys of launch or ANS inspection points. Additionally, maximum boating density may be estimated via collection of watercraft registration within townships and counties with little out-of-area visitation (JFNew 2007).

Counts of vehicles and/or boat trailers at marinas and boat launches can provide estimates of watercraft origin (CDM Smith 2012).

Surveys of boats on the water provide a point in time depiction of boat use and allow collection of data on boat number, location, type, speed, and activity. Boat speed may be relevant dependent on overall project goals and management objectives and can be recorded generally as fast-moving (i.e., wake producing) or stationary and slow-moving (Lake Ripley Management District 2003). Additionally, moored, docked, or beached watercraft may be recorded (Warren and Rea 1989). Launch and ANS inspection point data can provide insight into the number and types of watercraft on a lake during a particular time and general information on the point of origin. Watercraft are generally classified as speed boats, pontoon boats, fishing boats, personal watercraft, sailboats, or paddle craft (canoes, kayaks, and inflatables).

A watercraft census provides either a snapshot of the number of boats on the lake or reservoir during a specific point in time or an estimate of potential maximum watercraft density. In order to provide the most accurate picture of actual usage, the census should capture activity at several points in time (Doshi 2006). While an estimate of the number of boats on the water during peak use periods is essential to any carrying capacity study, additional information, including boat type, boat speed, shoreline counts, and/or off-peak counts, offer insights on different aspects of overall use and management. For example, it may not make sense to base management protocols solely on the number of boats on the water but instead to factor in changes in the number of motor or speed boats, which typically need greater surface acreage for safe operation (Warren and Rea 1989). Analyses of spatial carrying capacity may also include indicators of boating safety such as analyses of historical and current boating accident data. These data can be viewed for the entire lake or by lake zones to indicate any areas of concern.

Social carrying capacity refers to visitors' perceptions of crowding as defined by the lake's users. This capacity is reached when conflict arises or when the user chooses to no longer use the lake (Colorado State Parks 2011).

Users' perceptions of preferred boating density are measured via survey instruments. These may include onsite field surveys at ramps and marinas, telephone surveys, and/or mail surveys. Generally, responses to onsite surveys are aimed at perceptions of crowding on a specific day, whereas users' responding to mail-back or telephone surveys report their overall perceptions of crowding. Social carrying capacity surveys most commonly utilize a 5- or 9-point Likert-type scale or digital enhanced photographic simulations to gauge users' perceptions of crowding (Bosley 2005).

Onsite contact surveys can be administered on shore at boat ramps and/or marinas or on the lake by boat. Mail-back surveys are often distributed randomly to groups likely to have utilized the lake, including adjacent property owners, dock permit holders, marina slip renters, and campers. It is important to develop a sampling plan, which results in a representative sample of the user groups of interest (ERM, Inc. 2004). For example, many studies have found that, especially in rural areas, crowding thresholds of residents are significantly lower than those of visitors coming from metropolitan areas.

1.3 Beaver Lake Study Approach

The overall goal of this study was to summarize current recreational boating lake use during peak boating periods and to gather recreational boating users' perspectives to assist in the development of future lake management objectives. The primary focus is the identification of recommended spatial and social carrying capacity ranges specific to Beaver Lake and to characterize the extent to which boating falls within, under, or beyond the recommended capacity. Additional information on existing facilities was collected to inform lake managers about how facility capacity may affect spatial carrying capacity goals. Limited information was collected on the ecological carrying capacity.

The field activities, conducted during the summer of 2016, gathered data on boating activities during four survey weekends, including the Fourth of July and Labor Day holiday weekends and two additional weekends in July. Data about boat use on the water were collected via aerial flyovers. Simultaneously, ground crews conducted counts of empty boat trailers at public boat launch parking lots and campgrounds. The teams also counted empty marina slips. These field estimates provide primary data on volume of boat traffic and origination of boats on the lake.

A user survey targeting boaters at Beaver Lake was administered following the summer boating period in the fall of 2016. The survey follows the requirements and guidelines for federally sponsored data collections and was approved by the U.S. Office of Management and Budget (OMB). This survey provides critical information on user characteristics, on-water activities, and perceptions of safety, crowding, and user preferences. The survey was offered both online and via mail-out/mail-back format. The survey had a response rate of 45 percent and provided a statistically valid sample for the analysis. Results collected provide a wide variety of information and key results of the survey are provided throughout the main report. Details on the development, administration, and resulting responses from the survey are provided in full in Appendix B.

A recommended carrying capacity benchmark range, expressed as acres per boat, was developed based on the Water and Land Recreation Opportunity Spectrum (WALROS) methodology developed by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) (U.S. Bureau of Reclamation 2011). WALROS is a widely accepted method used to systematically classify recreational opportunities. WALROS considers the physical, social, and managerial attributes of a lake to classify it along a spectrum of urban, suburban, rural-developed, rural-natural, semi-primitive, and primitive recreation opportunities. Each WALROS classification has an associated recommended range of boating densities to achieve an appropriate carrying capacity for that lake's setting. from several sources. The WALROS analysis for Beaver Lake was conducted using the expertise of the Beaver Lake Project Office lake management staff (see Appendix C for the complete WALROS analysis). A literature review was conducted to develop spatial benchmark ranges for boating density based on the setting, typical activities, and types of boats used at Beaver Lake (Appendix A). Additionally, a survey question asked respondents to identify their preferences for boating density to characterize the social boating capacity. Both the spatial and social capacities were used to validate the WALROS range.

The recommended carrying capacity benchmark range from WALROS and the literature review was compared to observed boat densities as derived from the 2016 summer field study. The data and analyses provide a foundation for analyzing critical questions for lake management. Estimates can be made about the available capacity for growth in lake boating use and how existing facilities are

contributing to lake uses. From this information, lake managers can better plan for the future of Beaver Lake and strive for a healthy, balanced level of recreational boating.

1.4 Document Organization

This report documents the methods and results of the Beaver Lake boating carrying capacity study. The report is organized as follows:

- Section 2 describes the study area, including study zones, lake features, useable surface area, existing infrastructure, demographic characteristics, user characteristics (from the survey results), and visitation levels.
- Section 3 describes previously collected data on boating safety and crowding at Beaver Lake and incident data to describe the current safety conditions at the lake.
- Section 4 describes the methodology and results of the field studies to characterize the existing boat density at Beaver Lake, including data on boat origin and facility capacity.
- Section 5 presents the results of the user survey and perceptions related to safety and crowding to derive the social carrying capacity.
- Section 6 details results of the literature review and WALROS analysis used to develop the recommended ranges for boat density for Beaver Lake.
- Section 7 provides a summary of the analysis and conclusions about recommended carrying capacities for boating recreation at Beaver Lake.
- Section 8 lists the sources cited in the preparation of this report.

Section 2

Study Area Description

This section provides the context and setting for the lake against which the results of the study are interpreted. The context and setting of the lake includes its physical features and the social and economic characteristics of the surrounding area and the users of the lake.

2.1 Study Zones

For purposes of this study, data were collected, analyzed, and reported on by study zones. Based on discussions with Beaver Lake managers, the lake was divided into five study zones (**Figure 2-1**). The study zones were identified as areas that have different physical characteristics that may relate to different patterns of boat use or management strategies. For example, the southern end of the lake (Zones 4 and 5) is very narrow and can be shallow, making this area more attractive to fishermen, while the middle section of the lake (Zones 2 and 3) contains wide spaces that allow for sailboats and attract water skiers.

Data were collected by specific location to the maximum extent possible, i.e., by specific boat launch or marina location. The results are presented both in aggregate for the entire lake and by the lake study zones. Delineation of the lake into study zones not only allows analysis of individual portions of the lake but may also assist in future development of zone-specific management criteria based on the results of this study.

2.2 Lake Features

The Beaver Lake watershed is 1,192 square miles in size, with the lake itself estimated to be approximately 44 square miles. At the top of the conservation pool (at an elevation of 1,120 feet above sea level), Beaver Lake has approximately 28,299 surface acres. The water levels in the lake vary year to year, depending on local weather, particularly rainfall. Because Beaver Lake is a reservoir and its water level fluctuates by design, the surface area and depth will also vary. For the purposes of shoreline planning and management, USACE uses the top of the conservation pool at an elevation of 1,120 feet above sea level as the standard lake position. Average depth of the lake is 60 feet. Other published estimates of the size of Beaver Lake may use a different lake surface elevation or a different interpretation of the lake boundaries such as the boundary between the river and the lake.

USACE indicated that three management zones are present at Beaver Lake and are used as the basis for patrols: North, Middle, and South. These management zones roughly correspond to the zones as follows:

- North: Zone 1
- Middle: Zones 2 and 3
- South: Zones 4 and 5

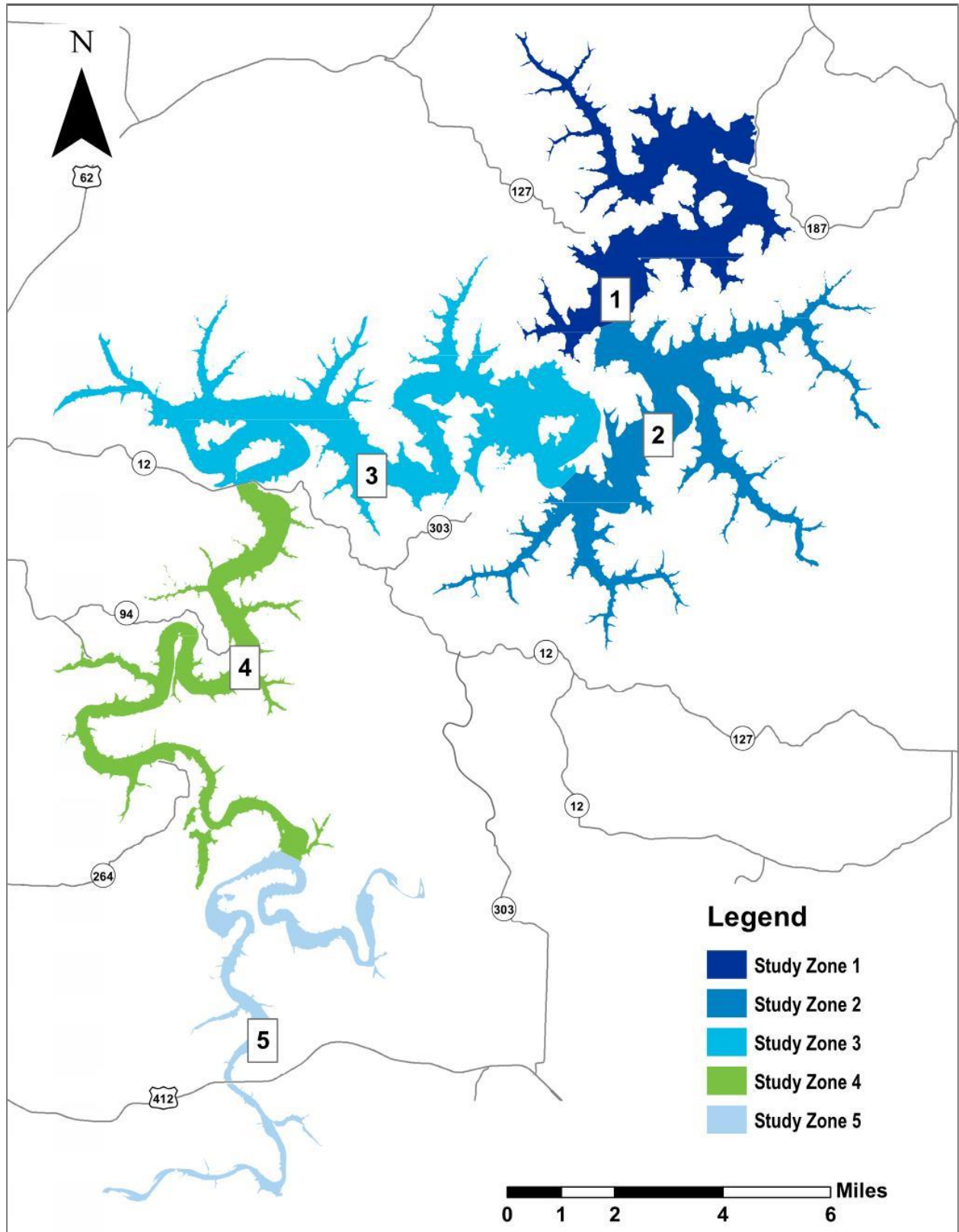


Figure 2-1. Lake Study Zones

2.3 Useable Surface Area

The calculation of boating density (acres per boat) relies on useable acres. Unusable water is defined as water that is only safe for operating non-motorized watercraft. Areas around marinas, boat docks, swim areas and shallow areas close to shore are typically excluded from the useable water area. **Figure 2-2** shows a portion of the lake considered an unusable area. **Figure 2-3** shows a useable water portion of the lake.

To identify the useable areas of Beaver Lake, the shoreline when the lake is at elevation 1,110 (10 feet lower than the top of the conservation pool) was digitized as a geographic information system (GIS) shapefile (polygon). This shoreline that is based on a lower lake elevation excludes low water areas and very narrow portions of the lake such as the southern end of the lake where it transitions into the White River. This means that from the edge of the useable lake area shapefile boundary to the edge of the lake when it is at an elevation of 1,120 feet above sea level, the water would be at least 10 feet deep at all locations. By using this lower elevation as a starting point, it was not necessary to buffer the entire shoreline to account for areas close to shore that might be too shallow for active boat use.



Figure 2-2. Unusable Water near Prairie Creek Marina



Figure 2-3. Useable Water

A 150-foot buffer zone was applied around all private, community, and resort docks. This 150-foot distance was based on the estimated average depth of docks plus a distance of 100 feet. Arkansas law requires that boats remain at idle within 100 feet of any structure [Arkansas Code 27-101-202(3)]. A GIS polygon layer of the marina docks was buffered with that 100-foot buffer zone based on the law. Designated swim areas were classified as unusable for boating, as no boats are allowed in those areas. Areas around known no-wake buoys were given a 100-foot buffer as well. A buffer zone of 100 feet was applied to areas near bridges in accordance with state law. Restricted areas around the four water supply intakes and the restricted area near the dam were also removed from the total useable surface area.

The total unusable area is the difference in area between the lake surface at the top of the conservation pool (28,299 acres at elevation 1,120) and the useable lake area shapefile boundary (elevation 1,110) minus the areas deemed unusable by the above factors. This analysis identified a total of 3,898 acres of unusable area. **Table 2-1** shows the number of useable acres by lake zone, and **Figure 2-4** shows the useable areas on a map of the lake. Total useable acres are estimated to be 24,401 acres, or 86 percent of the total surface water acres at the top of the conservation pool. Zone 3 has the largest total useable acres while Zone 5 has the smallest (**Table 2-1**).

Table 2-1. Useable Surface Water Acres by Study Zone

| Study Zone | Total Surface Water Acres at Top of Conservation Pool | Useable Water Surface Acres | Percent of Total Lake Area that is Useable |
|------------|---|-----------------------------|--|
| Zone 1 | 5,732 | 5,104 | 89% |
| Zone 2 | 6,245 | 5,473 | 88% |
| Zone 3 | 8,524 | 7,493 | 88% |
| Zone 4 | 4,599 | 4,051 | 88% |
| Zone 5 | 3,199 | 2,280 | 71% |
| Total | 28,299 | 24,401 | 86% |

2.4 Existing Infrastructure

Water-based recreational activities are critically linked with infrastructure such as boat ramps, marinas, swim beaches, and private docks. At Beaver Lake, there are 12 developed parks, 2,008 acres of campgrounds, and over 650 individual campsites. Other amenities include picnic sites, group picnic shelters, swimming beaches, hiking trails, boat launch ramps, sanitary dump stations, and restroom and shower facilities. This section focuses on the land and water infrastructure that provides access to the lake, including private and community boat docks, marinas, resorts, public boat launches, and camping and recreation areas.

2.4.1 Private and Community Boat Docks

Boat docks, or private floating facilities, are only permitted on USACE lakes in areas allocated as *Limited Development Areas* through the lake's SMP in accordance with 36 Code of Federal Regulations 327.30, Shoreline Management of Civil Works Projects. Applicants for boat docks must have ready access to the shoreline either by ownership of adjoining property (within 200 lateral feet of the government property line) or deeded perpetual lake access. Each individual household can have a maximum of two slips and are not permitted ownership of more than one boat dock.

There are currently 1,813 private, community, and resort/club boat docks on Beaver Lake, with 5,175 associated slips. Private boat dock locations are shown in **Figure 2-5**. A summary of the number of docks and slips by study zone is shown in **Table 2-2**. The highest concentrations of docks are found in the middle and northern sections of the lake. The greatest number of docks and slips is found in Zone 3, and the lowest number of docks is found in Zone 5.

Table 2-2. Count of Private, Community, and Resort Boat Docks and Slips by Study Zone

| Study Zone | Private Docks | Private Slips | Resorts | Resort Docks | Resort Slips | Sailing Club Docks | Sailing Club Slips | Total Docks | Total Slips |
|------------|---------------|---------------|---------|--------------|--------------|--------------------|--------------------|-------------|-------------|
| Zone 1 | 424 | 1,138 | 1 | 1 | 8 | 5 | 72 | 430 | 1,218 |
| Zone 2 | 405 | 1,115 | 3 | 3 | 26 | | | 408 | 1,141 |
| Zone 3 | 541 | 1,527 | 2 | 3 | 52 | | | 544 | 1,579 |
| Zone 4 | 299 | 850 | 0 | 0 | 0 | | | 299 | 850 |
| Zone 5 | 131 | 375 | 1 | 1 | 12 | | | 132 | 387 |
| Total | 1,800 | 5,005 | 7 | 8 | 98 | 5 | 72 | 1,813 | 5,175 |

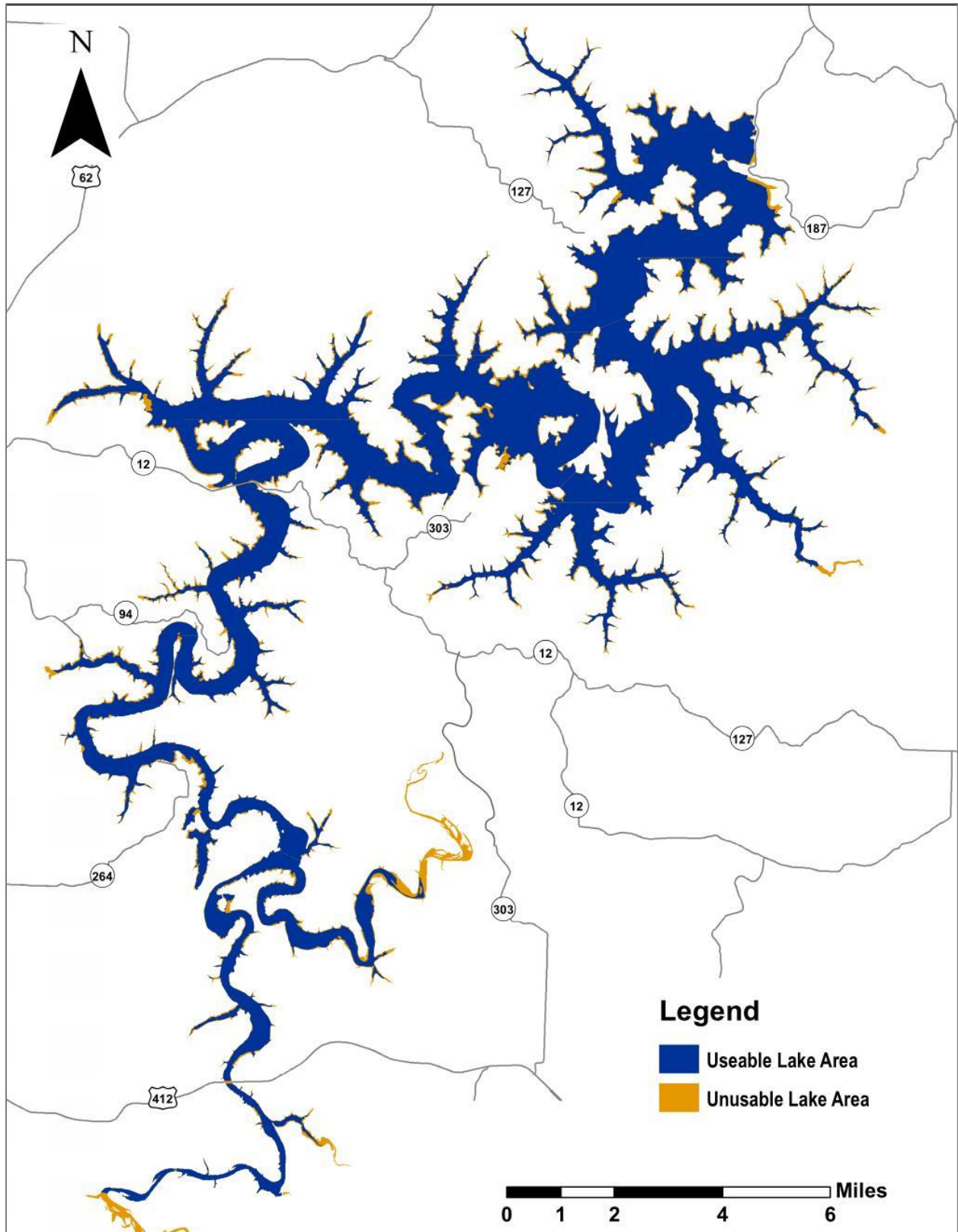


Figure 2-4. Useable and Unusable Lake Surface Area

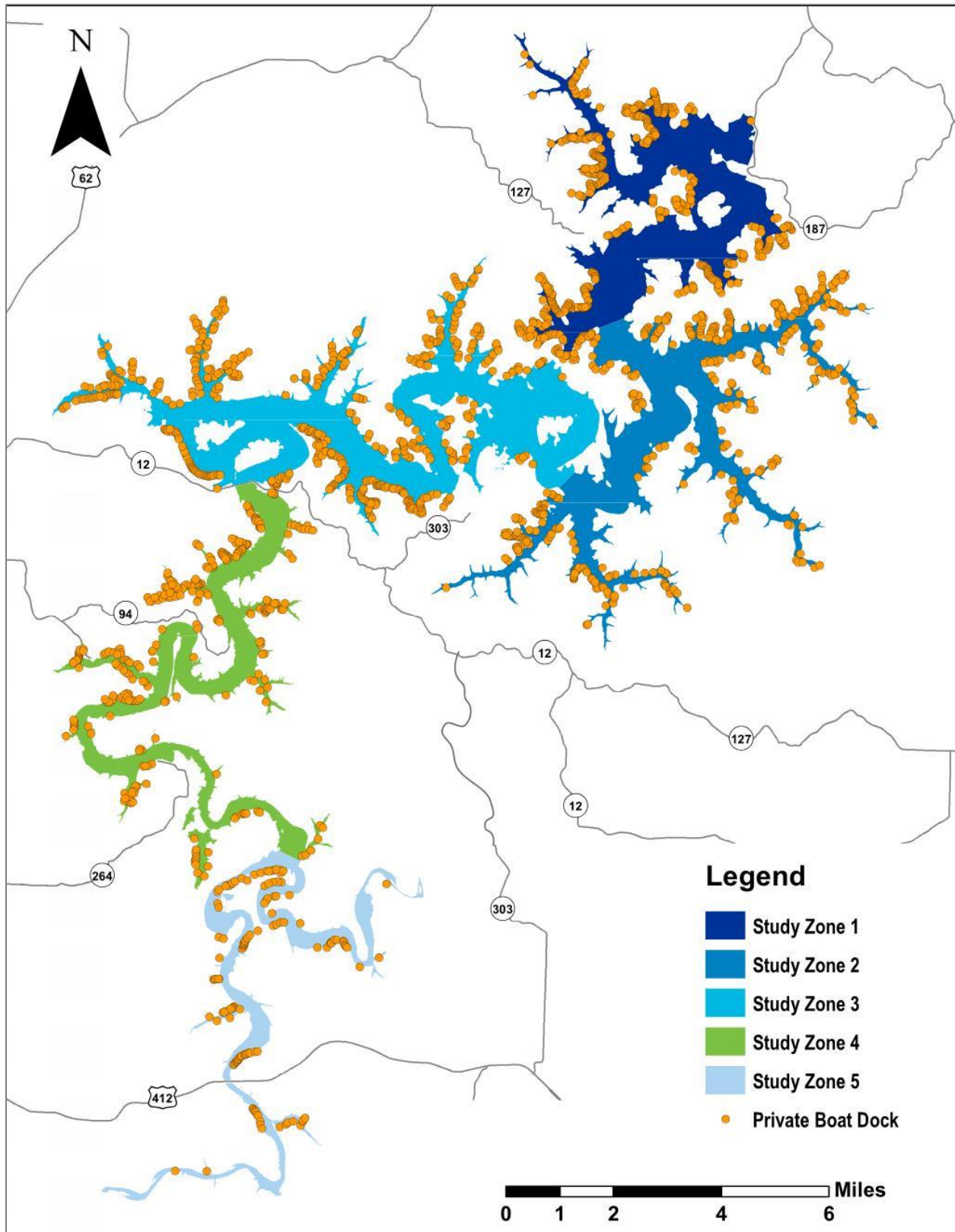


Figure 2-5. Private, Community, and Resort Boat Dock Locations

Figure 2-6 shows the distribution and concentrations of boat slips across the lake. For this analysis, the lake was broken up into a grid approximately 330 feet by 330 feet. Then the number of slips within a half mile of each gridded point is shown on the figure. The darker areas of shading shows areas with the greatest concentration of boat slips.

2.4.2 Marinas/Resorts

There are seven marinas at Beaver Lake, as shown on **Figure 2-7** and described in **Table 2-3**. These privately owned and operated marinas are within public campgrounds and day use areas managed by USACE. Marinas on Beaver Lake are all full service and provide gasoline, slip rentals, food service, and watercraft rentals.

At Beaver Lake, only wet storage slips are available (boats docked on the water and ready for use). For comparison, dry slip storage involves removing the boat from the water, generally via a crane or lift. The seven marinas on Beaver Lake offer a total of 1,976 wet slips available for rent to the public; none of the marinas offer dry storage. Prairie Creek Marina accounts for 37 percent of the total slips.

There are seven resorts that have docks and provide boats and lake access for guests. These resorts include Camp War Eagle, Ventris Trail's End, Lake Shore Cabins, Coppermine Lodge, Twin Coves, Beaver Lakefront, and Hide-A-Way.

Table 2-3. Characteristics of Beaver Lake Marinas

| Marina | Wet Storage Slips* | Boat Rentals | Restaurant |
|-----------------------|--------------------|--------------|------------|
| Hickory Creek Marina | 180 | Y | Y |
| Horseshoe Bend Marina | 160 | Y | N |
| Lost Bridge Marina | 232 | Y | N |
| Prairie Creek Marina | 733 | Y | Y |
| Rocky Branch Marina | 307 | Y | N |
| Starkey Marina | 156 | Y | N |
| War Eagle Marina | 189 | N | N |
| Total | 1,957 | | |

*Number is based on field counts and may differ from other sources of information such as the USACE Operations and Maintenance Business Information Link (OMBIL). For example, Lost Bridge has a dock that is not currently being used and is not included in this count.

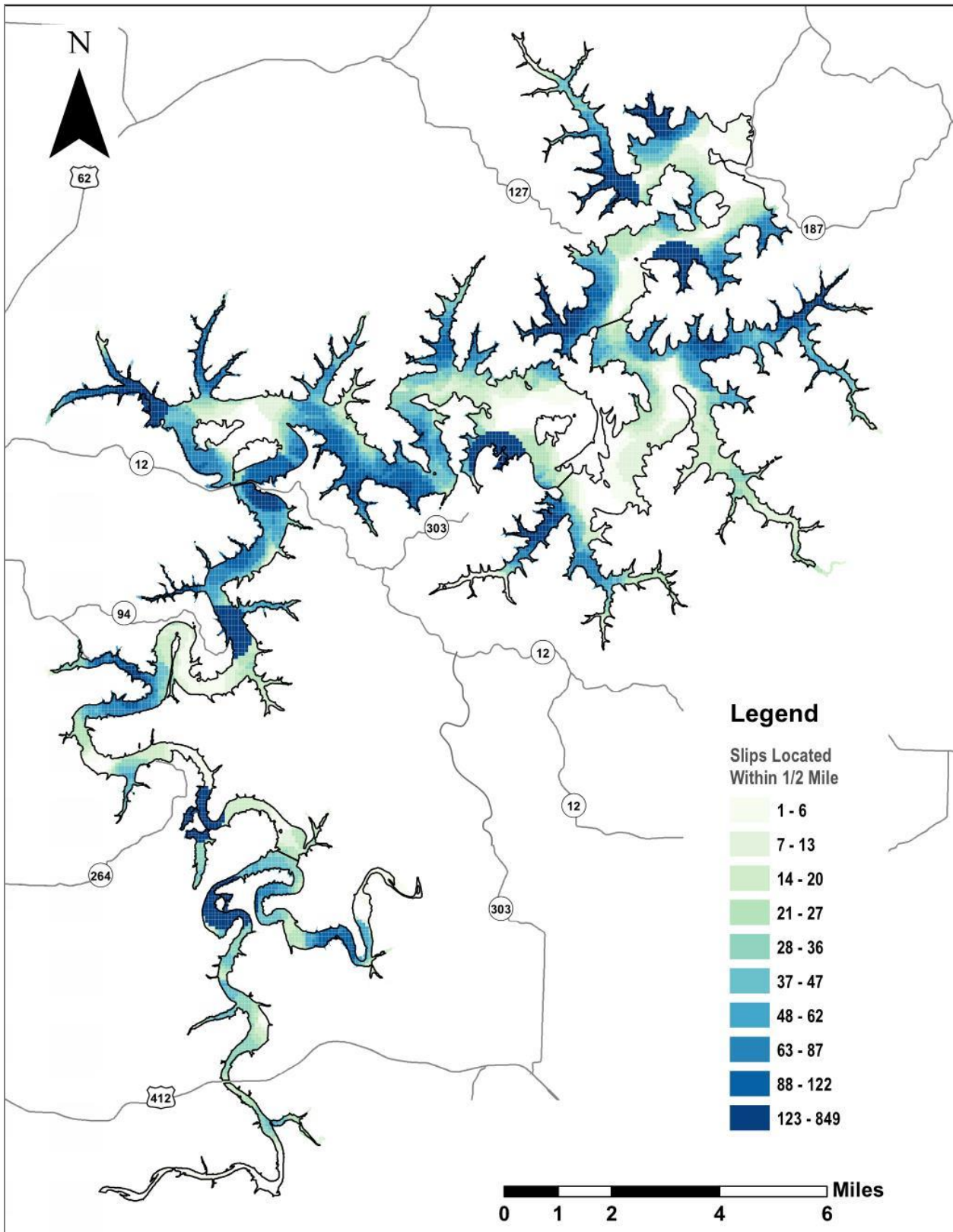


Figure 2-6. Concentrations of Private, Community, and Resort Slips on Beaver Lake

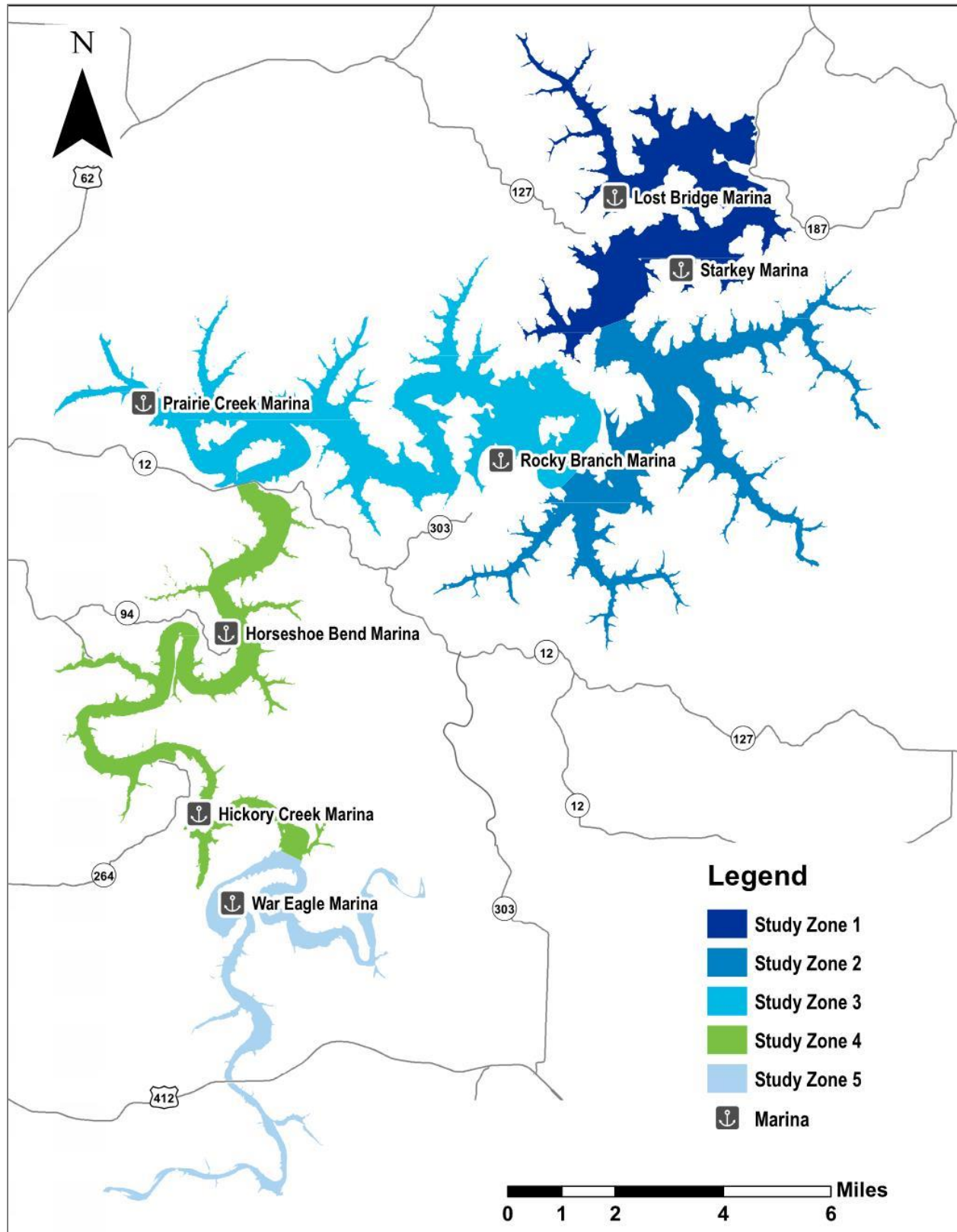


Figure 2-7. Beaver Lake Marinas

2.4.3 Public Boat Launches

There are 76 public boat launches geographically dispersed throughout Beaver Lake, as shown in **Figure 2-8**. Of these, 16 are in public recreation areas and 26 are out-granted to a non-USACE entity via license, easement, or other appropriate authorization. The remaining 34 are informal, end-of-road, launch areas. In total, there are 483 trailer and car spaces available at the boat launch sites.

2.4.4 Recreation Areas/Campgrounds

There are 21 public use areas and campgrounds either operated by USACE or out-granted around Beaver Lake, as shown in **Figure 2-9**. Day use and overnight use is permitted in some areas with an applicable fee. In total, these areas provide 1,645 car parking spaces and 493 boat trailer parking spaces. The characteristics of the recreation areas around the lake are summarized in **Table 2-4**.

Table 2-4. Characteristics of Beaver Lake Recreation Areas and Facilities

| Facility | USACE or Outgrant | Car Parking Spaces | Trailer Parking Spaces | Total Parking Spaces |
|----------------------------|-------------------|--------------------|------------------------|----------------------|
| Blackburn Creek | USACE | 5 | 0 | 5 |
| Blue Springs | USACE | 13 | 16 | 29 |
| Clifty Park | Outgrant | 20 | 10 | 30 |
| Dam Site | USACE | 69 | 30 | 99 |
| Dam Site - North Bluffs | USACE | 74 | 6 | 80 |
| Dam Site - Parker Bottoms | USACE | 18 | 0 | 18 |
| Dam Site - Peninsula | USACE | 224 | 0 | 224 |
| Dam Site - River | USACE | 86 | 18 | 104 |
| Dam Site - White Bass Cove | USACE | 4 | 0 | 4 |
| Dam Site Overlook | USACE | 21 | 0 | 21 |
| Hickory Creek | USACE | 243 | 81 | 324 |
| Horseshoe Bend | USACE | 196 | 30 | 226 |
| Indian Creek | USACE | 56 | 10 | 66 |
| Lost Bridge North | USACE | 52 | 21 | 73 |
| Lost Bridge South | USACE | 31 | 15 | 46 |
| Monte Ne | USACE | 11 | 15 | 26 |
| Prairie Creek | USACE | 372 | 177 | 549 |
| Rocky Branch | USACE | 58 | 41 | 99 |
| Starkey | USACE | 41 | 10 | 51 |
| Ventris | USACE | 2 | 10 | 12 |
| War Eagle | USACE | 49 | 18 | 67 |
| Total | | 1,645 | 509 | 2,153 |

Source: Provided by USACE Beaver Lake Project Office

Bold values indicate estimations of trailer parking spaces.

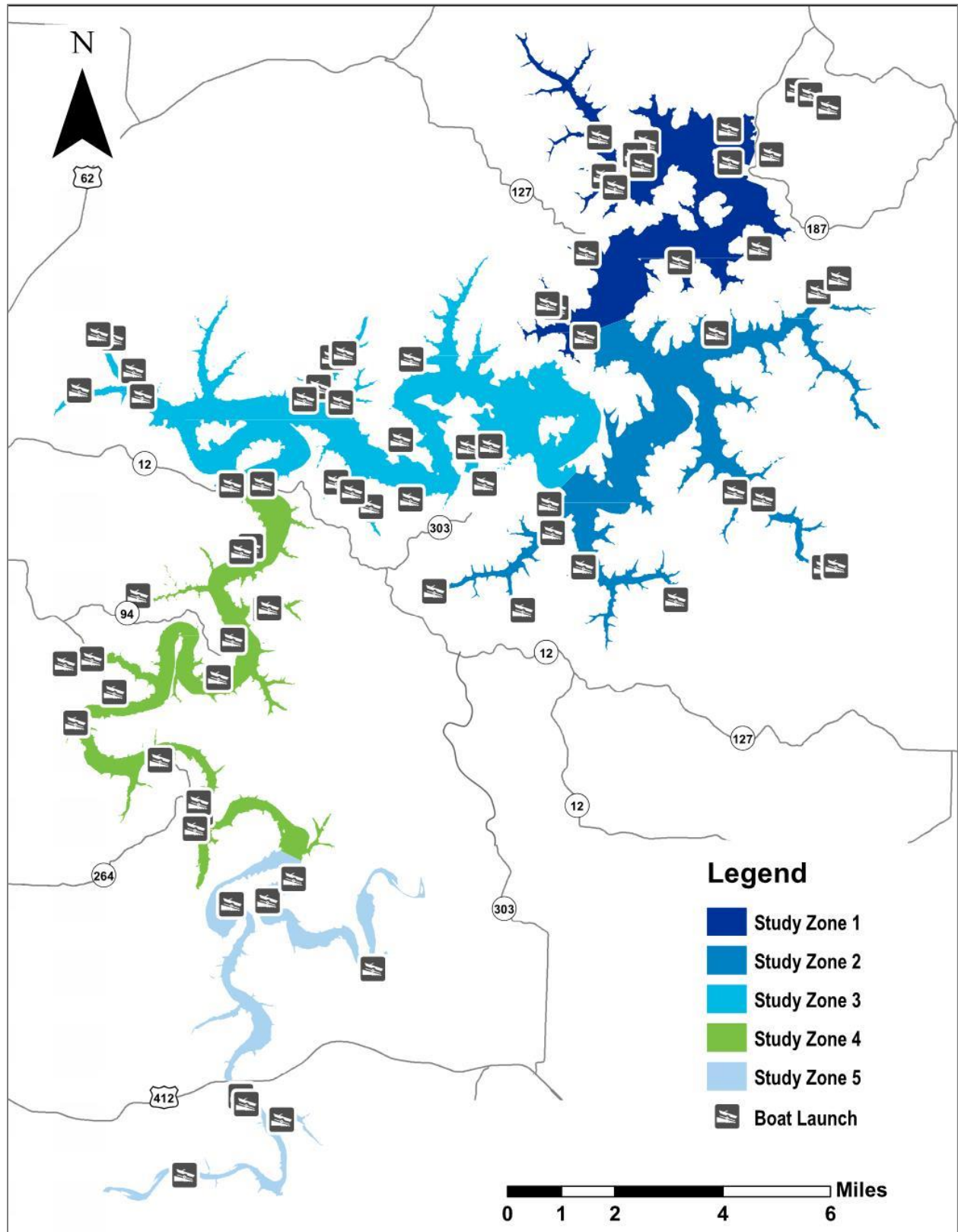


Figure 2-8. Public Boat Launches

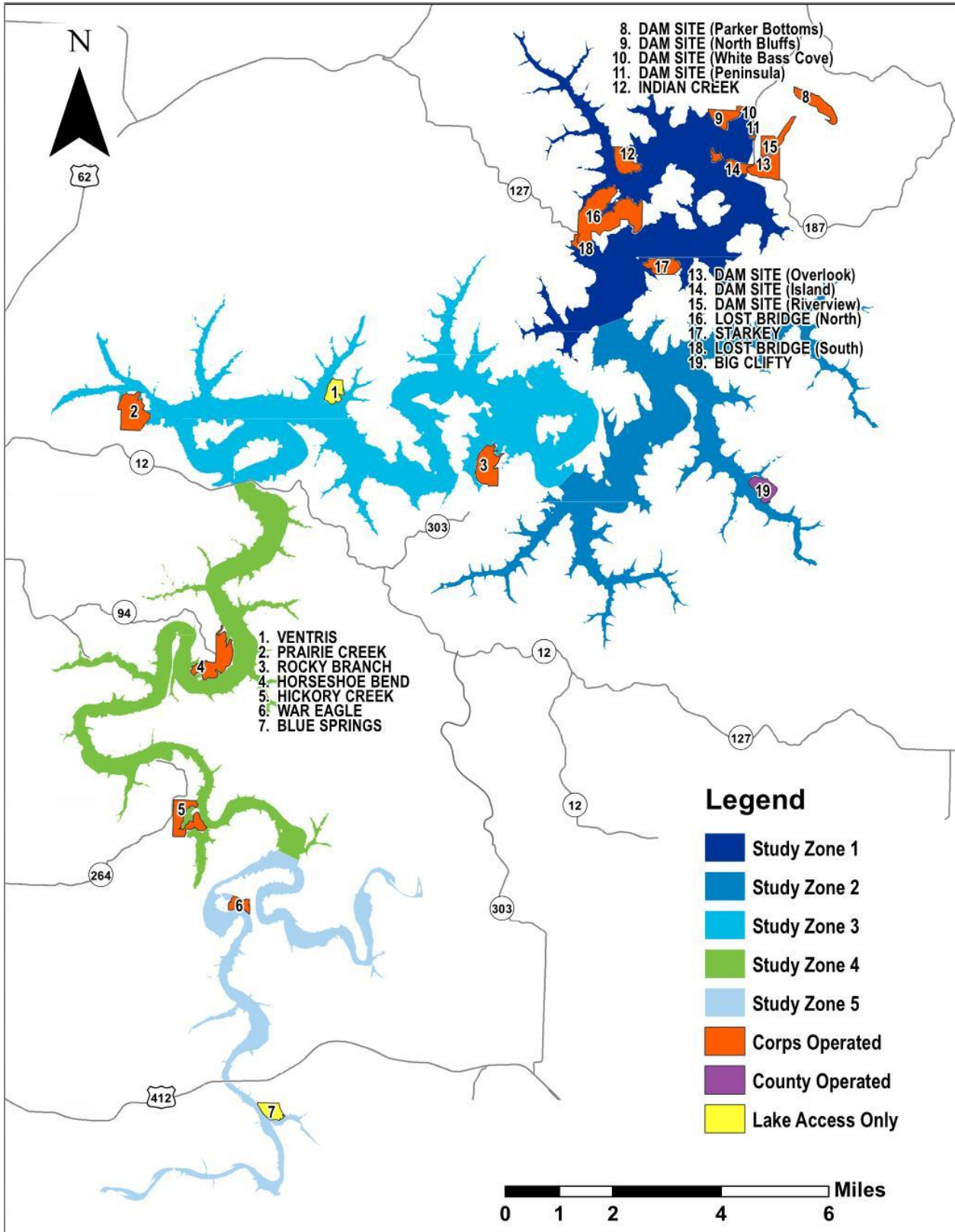


Figure 2-9. Public Use Recreational Areas

2.5 Demographic Characteristics

The Fayetteville-Springdale-Rogers Metropolitan Statistical Area (MSA) that surrounds Beaver Lake covers Benton, Madison, and Washington counties in Arkansas and McDonald County in Missouri (Figure 2-10). Unlike most MSAs that are centered on one urban core, a number of large distinct cities make up the MSA, and several are in close proximity to the Beaver Lake public access points: Rogers (5 miles from the Prairie Creek Marina), Bentonville (12 miles from the Prairie Creek Marina), Springdale (8 miles from the Hickory Creek Marina), and Fayetteville (20 miles from both the War Eagle and the Hickory Creek Marinas).

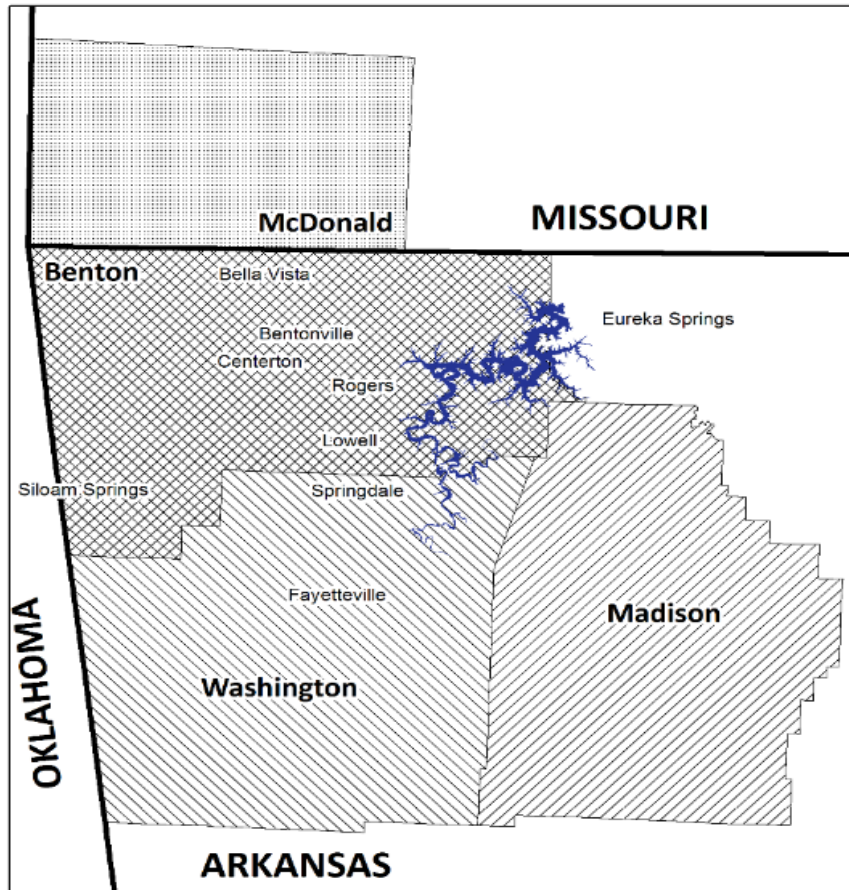


Figure 2-10. Fayetteville-Springdale-Rogers Metropolitan Statistical Area

Source: U.S. Census Bureau 2014

The Fayetteville-Springdale-Rogers MSA is the seventh fastest-growing economy among large metropolitan areas in the nation (IHS Global Insight 2014). The proximity to the lake and unique characteristics of each city in the MSA suggest that the observed growth in demand for recreation at Beaver Lake is likely to continue. Fayetteville, home of the University of Arkansas, is a major source of skilled labor in the region, with 44.8 percent of residents aged over 25 holding a bachelor's degree or graduate degree. Springdale and Rogers are home to Tyson Foods, a multinational food corporation, and J.B. Hunt, a trucking and transportation company. Thirty-four percent of Springdale residents are employed in one of the two sectors, while in Rogers, 22 percent of the population is employed in one of these sectors. Bentonville, the corporate headquarters of Walmart, is the smallest but fastest growing

city in the region. From April 2010 to July 2013, the city grew by 14 percent. Bentonville is also the wealthiest of the cities, with a median household income exceeding \$60,000 in 2015 (Gascon and Varley 2015).

The MSA has seen exponential growth in the past 50 years (**Figure 2-11**). All four counties have grown faster than national averages since 1971, with Benton and Washington counties growing the fastest (2.4 percent on average). This population growth has been accompanied by increases in economic prosperity as per capita income in the region has also grown faster than average. In northwest Arkansas, per capita income has grown 2.3 percent annually compared to 1.4 percent nationally (**Figure 2-12**) (Federal Reserve Bank of St. Louis 2015; Gascon and Varley 2015). While income and population growth both slowed slightly during the recession of 2008, both have recovered and returned to pre-recession growth rates. By 2011, the per capita personal income in the MSA had, for the first time, surpassed that of the United States (\$43,199 and \$42,459, respectively). In 2014, the per capita personal income in the MSA was 34 percent higher than the rest of Arkansas and 12 percent higher than the average per capita personal income in the United States.

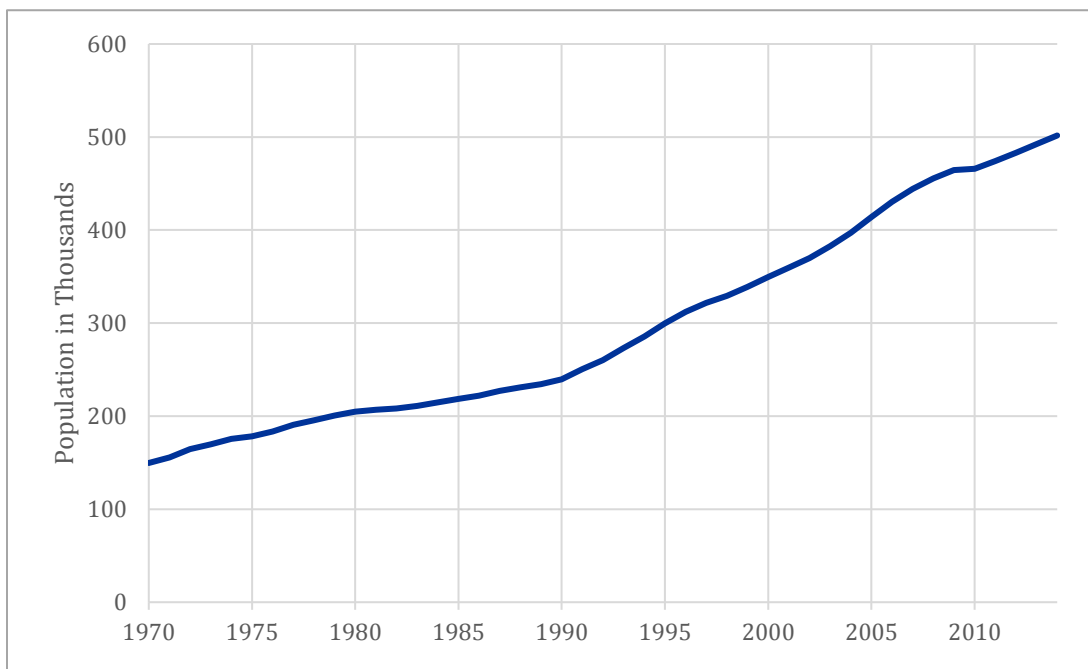


Figure 2-11. Resident Population in Fayetteville-Springdale-Rogers MSA

Source: <https://fred.stlouisfed.org/series/FASPOP>

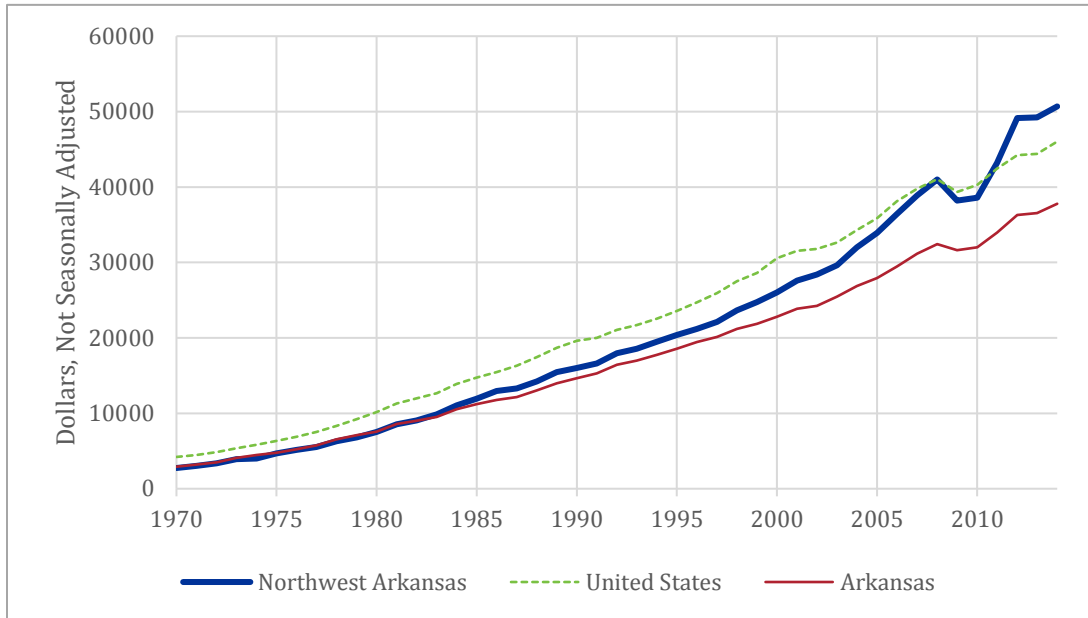


Figure 2-12. Per Capita Personal Income in Fayetteville-Springdale-Rogers MSA

Source: Federal Reserve Bank of St. Louis 2015

The Northwest Arkansas Regional Planning Commission (NWARPC) projects that the regional population will be well over half a million by 2035 (Figure 2-13 and Table 2-5). In the period from 2015 to 2035, NWARPC projects that the population of Springdale, Bentonville, Bella Vista, Lowell, and Centerton will more than double (Figure 2-14). Historical and future projected growth of the area suggests that demand for recreational activities at Beaver Lake will continue to increase.

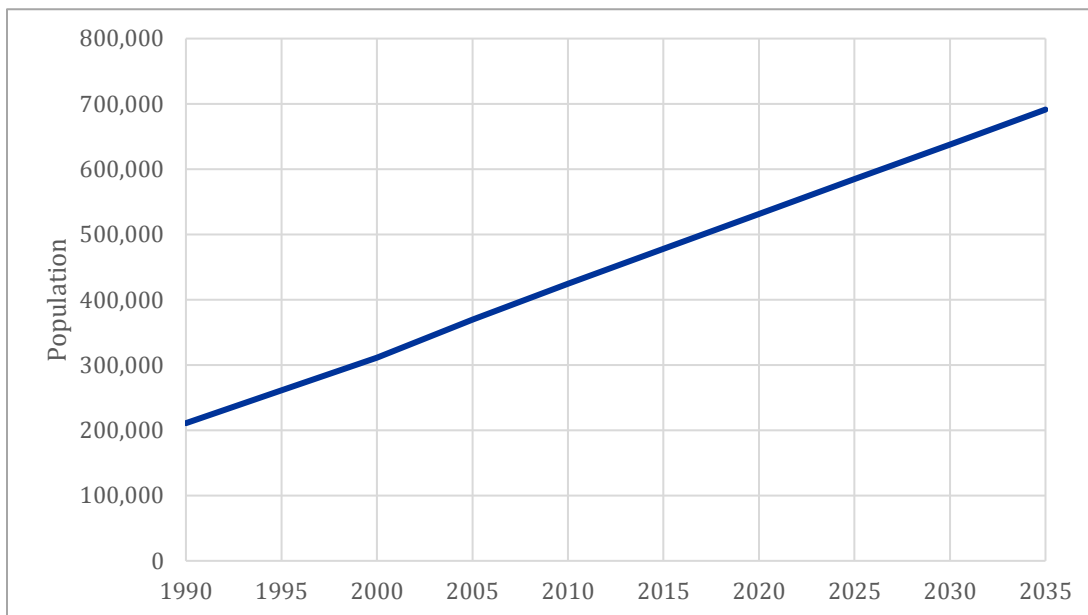


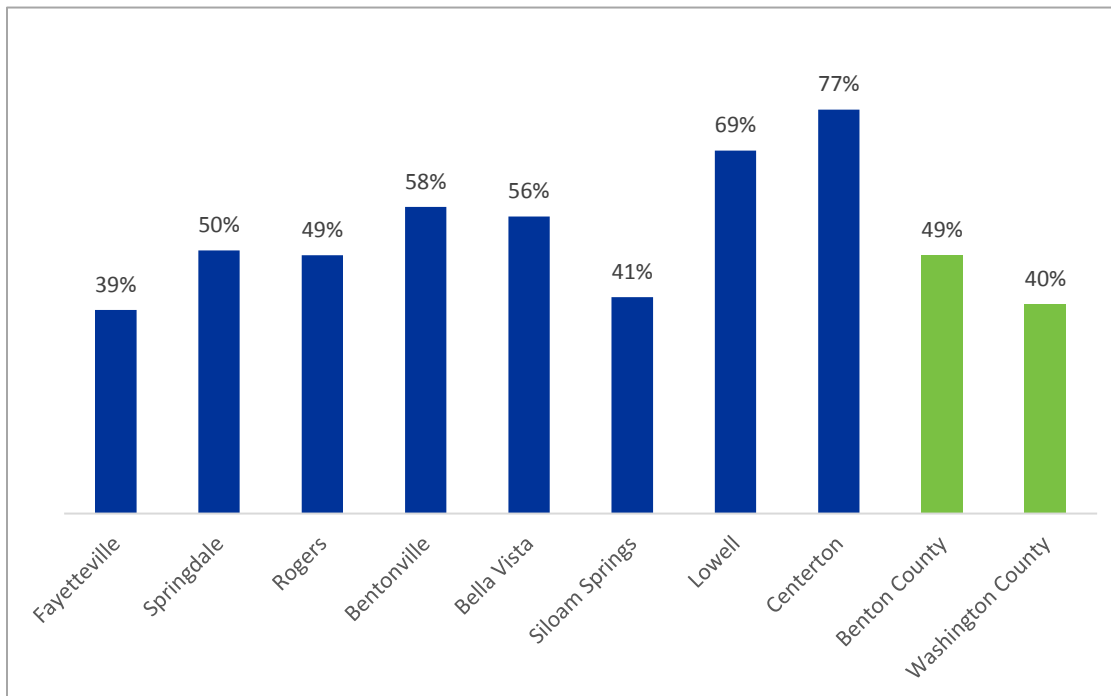
Figure 2-13. Northwest Arkansas Population Projections

Source: Parsons Brinckerhoff 2011

Table 2-5. Historical and Projected Population in Northwest Arkansas Region

| City/County | 1990* | 2000* | 2010 | 2020 | 2030 | 2035 |
|-------------------|---------|---------|---------|---------|---------|---------|
| Fayetteville | 42,099 | 58,047 | 73,580 | 89,321 | 105,061 | 112,931 |
| Springdale | 29,941 | 45,798 | 69,797 | 89,725 | 109,653 | 119,617 |
| Rogers | 24,692 | 38,829 | 55,964 | 71,600 | 87,236 | 95,054 |
| Bentonville | 11,257 | 19,730 | 35,301 | 47,323 | 59,345 | 65,356 |
| Bella Vista | 9,083 | 16,582 | 26,461 | 35,150 | 43,839 | 48,184 |
| Siloam Springs | 8,151 | 10,843 | 15,039 | 18,483 | 21,927 | 23,649 |
| Lowell | 1,224 | 5,013 | 7,327 | 10,379 | 13,430 | 14,956 |
| Centerton | 491 | 2,146 | 9,515 | 14,027 | 18,539 | 20,795 |
| Benton County | 97,499 | 153,406 | 221,339 | 283,259 | 345,179 | 376,139 |
| Washington County | 113,409 | 157,715 | 203,065 | 247,893 | 292,721 | 315,135 |
| Region | 210,908 | 311,121 | 424,404 | 531,152 | 637,900 | 691,274 |

*Data are actual counts from the U.S. Census; projections based on Census figures and building permit trends compiled by NWARPC.

**Figure 2-14. Projected Population Growth in Northwest Arkansas from 2015 to 2035**

2.6 User Characteristics

This section presents characteristics of lake users according to results of the user perception survey. Full details on the survey administration and results are provided in Appendix B. Seventy percent of the respondents live within 0.25 miles of the Beaver Lake shoreline. Of these respondents who reside along the shoreline, 26 percent report living in Zone 1, 18 percent in Zone 2, 32 percent in Zone 3, 17 percent in Zone 4, and 7 percent in Zone 5. Most survey respondents permanently reside in Arkansas (79

percent). The other frequently mentioned states of permanent residency include Kansas (6 percent), Missouri (3 percent), and Oklahoma (3 percent).

Most respondents regularly boat at Beaver Lake, as shown in **Figure 2-15**. Most boaters have experience boating (80 percent boating for 11 years or more) but less experience on Beaver Lake (37 percent have been boating on Beaver Lake for 10 years or less).

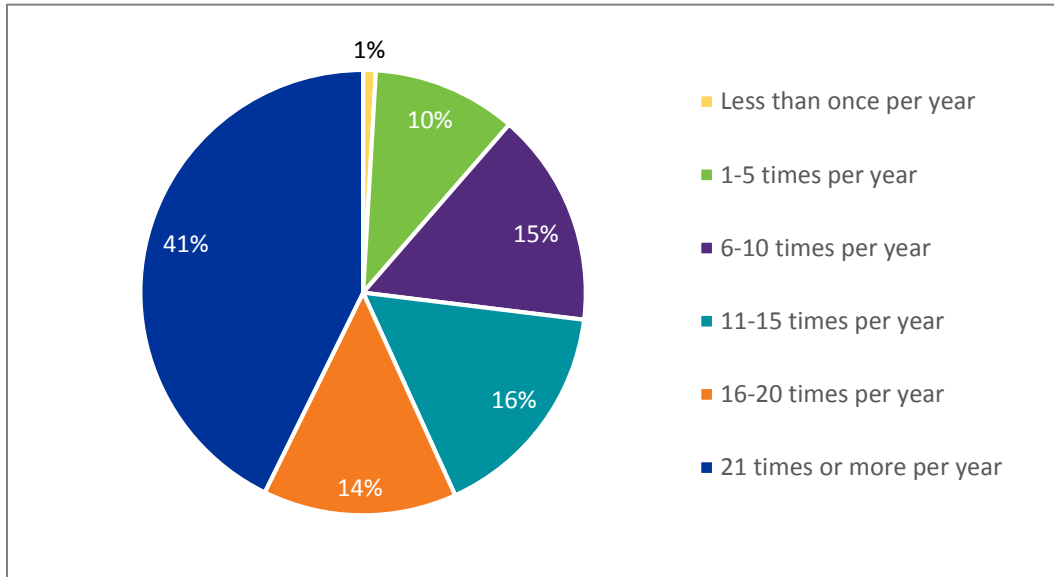


Figure 2-15. Average Number of Times Users Engage in Boating Activities at Beaver Lake

When asked which zone is primarily used during an average recreational boating trip, Beaver Lake boaters indicated that Zone 3 is used most often, followed by Zone 1 and Zone 2 (see **Figure 2-16**). Five percent of respondents did not indicate a zone, possibly because they were not able to choose one primary zone, they did not understand the question, or they do not know which zone they recreate in.

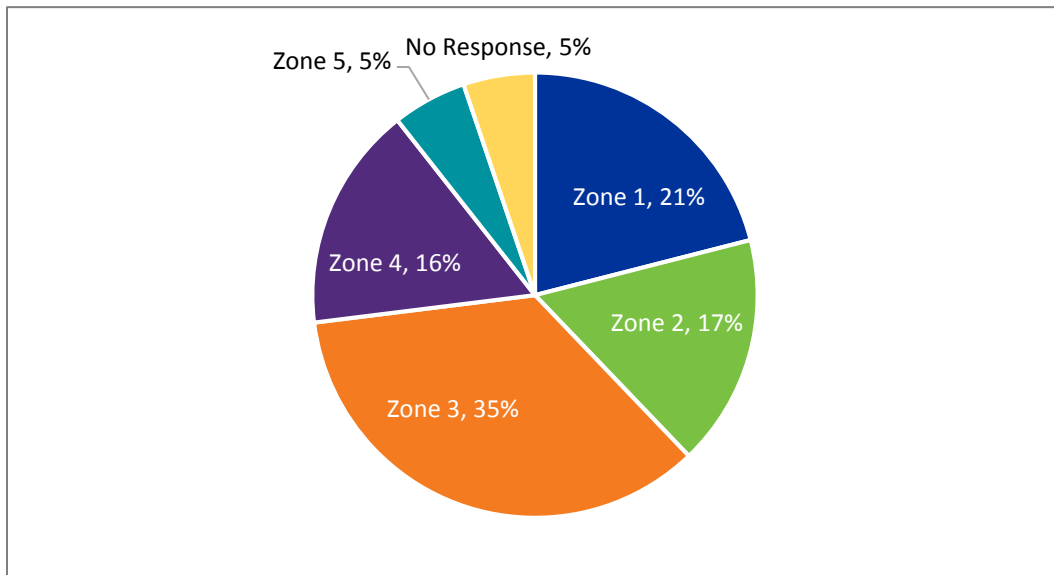


Figure 2-16. Primary Study Zone Used during a Typical Recreational Boating Trip

Respondents engage in a variety of activities such as cruising (32 percent), relaxing (26 percent), fishing (24 percent), and swimming (23 percent). Additional frequent activities include water skiing, tubing, kayaking, and sailing.

The majority of the boats used on the lake are between 21 and 28 feet in length (60 percent), with 16 to 20 feet in length making up an additional 33 percent of the boats. The most commonly used boat types are pontoon (30 percent), ski or wake boats (24 percent), runabout/speedboats (20 percent), and fishing/bass boats (14 percent).

Of all survey respondents, 58 percent indicate that the boat they use most often is kept at their private or community boat dock. Twenty-nine percent indicate that the boat is kept at a marina while 13 percent transport their boat to the lake via trailer (or some other method).

Eighty percent of the survey respondents are male and 88 percent are 45 years of age or older. Sixty-five percent of respondents hold either a bachelor's or post-graduate degree. A large proportion of respondents elected not to disclose their household income (21 percent). Of those that did, 79 percent report a household income exceeding \$75,000 per year.

2.7 Visitation

Visitation data, shown in **Table 2-6**, were provided by USACE for fiscal years (FY) 2009 through 2012. During this time period, there has been a consistent annual visitation of approximately 2.5 million visitors. In addition to fishing and boating activities on the lake, visitors also participate in camping, hunting, hiking, swimming, scuba diving, spelunking, and sightseeing.

Beaver Lake is home to eight national bass tournaments per year and multiple local fishing tournaments as well as other boating recreational events for power boaters.

Table 2-6. Beaver Lake Visitation Data

| Year (FY) | Visitor Hours | Visits | Dispersed Visitor Hours |
|-----------|---------------|-----------|-------------------------|
| 2009 | 18,365,184 | 2,628,560 | 3,262,040 |
| 2010 | 18,983,532 | 2,643,229 | 3,132,346 |
| 2011 | 17,497,453 | 2,439,917 | 2,904,190 |
| 2012 | 19,167,010 | 2,457,662 | 2,820,528 |

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Section 3

Existing Data and Studies Related to Boat Crowding and Safety

Existing data and studies provide information on historical and current perceptions and realities of crowding and safety at Beaver Lake. This section summarizes comments collected during the most recent MP/SMP update process as well as data available on boating incidents at Beaver Lake and other lakes in Arkansas¹.

3.1 MP/SMP Comments

The Little Rock USACE District conducted scoping in early 2015 on the proposed update of the Beaver Lake MP. The MP is the guiding document that describes how the resources of the lake will be managed and provides a vision for how the lake should look in the future. Based on comments received during MP scoping workshops, USACE decided to revise the MP and the SMP concurrently to allow the public the opportunity to understand the relationship between the plans and comment on the effects of proposed revisions. Therefore, a second scoping process was conducted in early 2016 to gather input on both the proposed MP and SMP updates. The SMP is a comprehensive plan for managing the shoreline, including effects of human activities on the shoreline. As a result of these public participation processes, USACE received approximately 670 comment submittals from members of the public. While these comments primarily will be used to develop the updated MP and SMP, they also provide an indication of user perceptions of conditions at Beaver Lake.

Comments particularly related to this boating carrying capacity study included those related to boat size, noise, or speed and those related to no-wake zones. Of the total comments received in both 2015 and 2016, approximately 24 percent of the commenters (163 comments) indicated a desire for restrictions on boat size, noise, or speed. Additionally, 14 percent of the commenters (93 comments) indicated a desire for the creation of additional no-wake zones throughout the lake. Many of the concerns in each of these categories related specifically to a desire for greater boater safety such as increased enforcement of rules or increased patrols.

Commenters also indicated desires regarding the overall setting of Beaver Lake. Approximately 47 percent of all commenters (315 commenters) indicated that they would like to maintain the natural beauty and peaceful environment of the lake (CDM Smith 2016).

3.2 Boating Incident Summary

To better understand the extent that boating conditions at Beaver Lake may be unsafe, data on fatalities and boating incidents were collected and analyzed overall and by study zone. Fatality data were

¹ It should be noted that a recreation survey was conducted in 1995 at Beaver Lake. The report aimed to increase the USACE's "understanding of and ability to manage the potential for rapid increases in development and rezoning" (Titre et al. 1995).

provided by the Beaver Lake USACE Project Office. Additional data on fatalities as well as boating incidents were provided by the Arkansas Game and Fish Commission.

3.2.1 Bodily Harm and Fatalities

At Beaver Lake, 74 percent of all fatalities in the past 5 years were due to drowning (**Figure 3-1**), and 82 percent of the victims were male (**Figure 3-2**). During this time, 4 of the 19 fatalities occurred while the victim was engaged in boating activities. In addition to fatalities, incidents that result in bodily harm were collected from data provided by Arkansas Game and Fish Commission. There were 17 boating incidents that occurred resulting in bodily injury (**Figure 3-3**). Boating-related fatalities were relatively evenly dispersed geographically across the lake; however, incidents that resulted in injury occurred more frequently in Zones 1, 2, and 3 than in Zones 4 and 5. Of the boating-related fatalities, two occurred in early spring and two occurred during the summer. All 17 incidents that resulted in bodily injury occurred during the summer boating season.

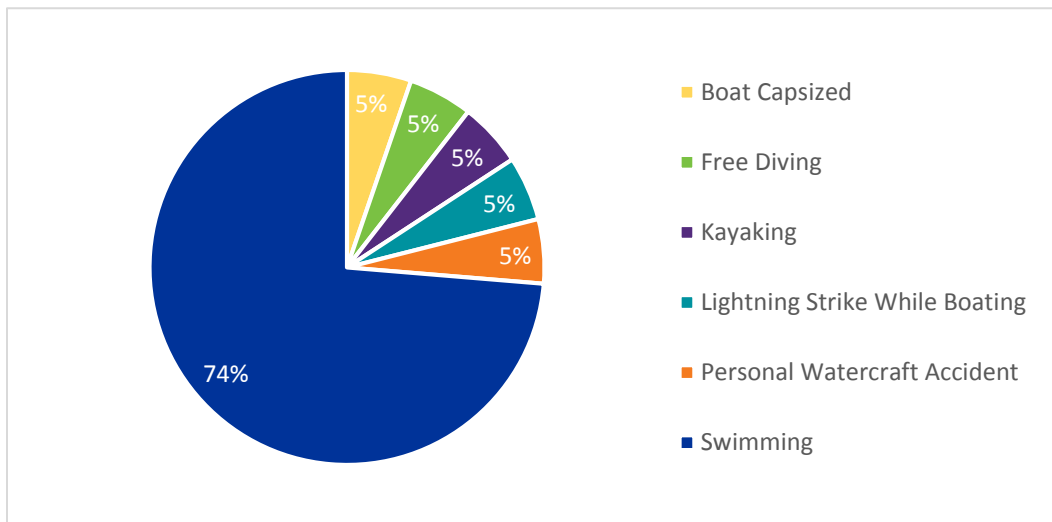


Figure 3-1. Fatalities at Beaver Lake by Type (2011–2016)

Source: Beaver Lake USACE Project Office

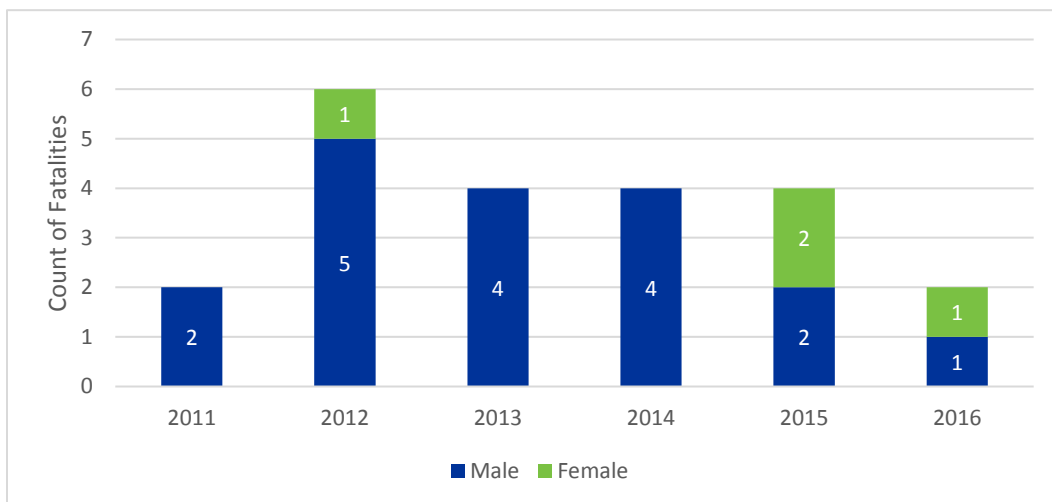


Figure 3-2. All Fatalities for All Types at Beaver Lake by Gender

Source: Beaver Lake USACE Project Office

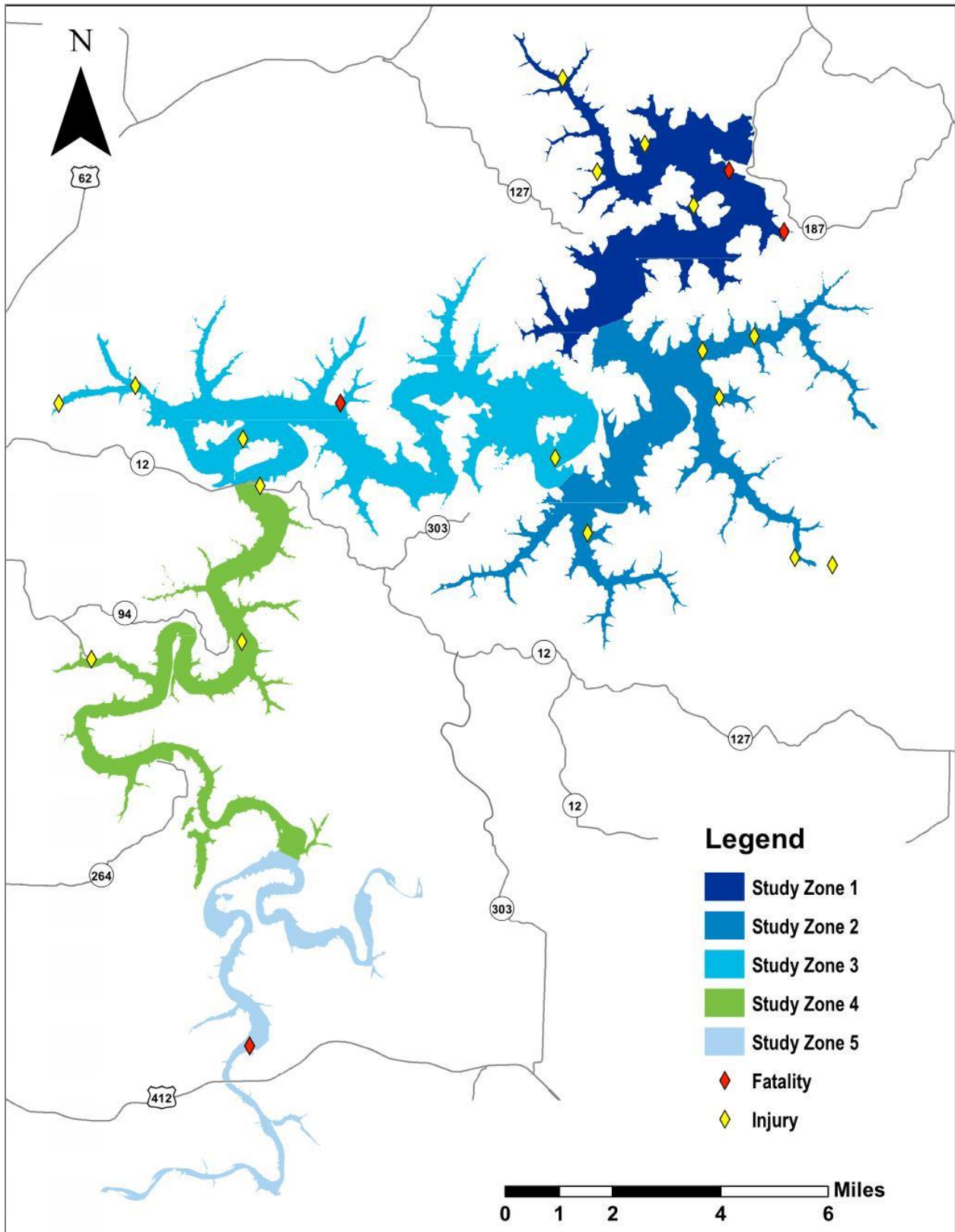


Figure 3-3. Boating-Related Fatality and Bodily Injury Incident Locations (2011–2016)

Source: Arkansas Game and Fish Commission 2016

3.2.2 Crowding-Related Boating Incidents

The Arkansas Game and Fish Commission reported 56 known boating incidents on Beaver Lake from 2011 to 2016 that had geographic location information associated with the report (Arkansas Game and Fish Commission 2016). Please note that 2016 incident reports are only through August. These 56 incidents include the 21 boating-related incidents that involved bodily harm or fatalities as described above.

Of these 56 reports, 16 were deemed to be caused by crowding-related issues on the lake, and 40 were not caused by any form of crowding (**Figure 3-4**). For the purposes of this study, “crowding incidents” are defined as any incident that could have been avoided if another occupied boat was not present in the direct vicinity. Crowding incidents require two or more boats to be in close proximity to each other for the incident to occur. Crowding incidents include boat-on-boat incidents (except if one of the boats was docked at a marina), boat-on-wake incidents, and boat-on-tube incidents. Non-crowding incidents are defined as any incident that did not involve the presence of another occupied boat in the direct vicinity. Non-crowding incidents included boat fires and explosions, boat-on-dock incidents, capsized boats, boats that were sinking due to malfunction, boating incidents caused by large waves, boats hitting submerged and non-submerged objects, boats running ashore (grounding), passengers falling overboard, as well as swimming, skiing, and tubing incidents not involving a second boat.

The greatest number of incidents occurred in 2012, with 38 percent of those incidents determined to be crowding-related. *Note: The 2015 and 2016 data indicate a noticeable decrease in incidents. However, recent legislative changes on reportable incidents increased the reporting amount from \$500 to \$2,000. Therefore, incidents where damage is less than \$2,000 are no longer reported (Arkansas Game and Fish Commission 2015), which may account for much of the reported decrease in 2015 and 2016.*

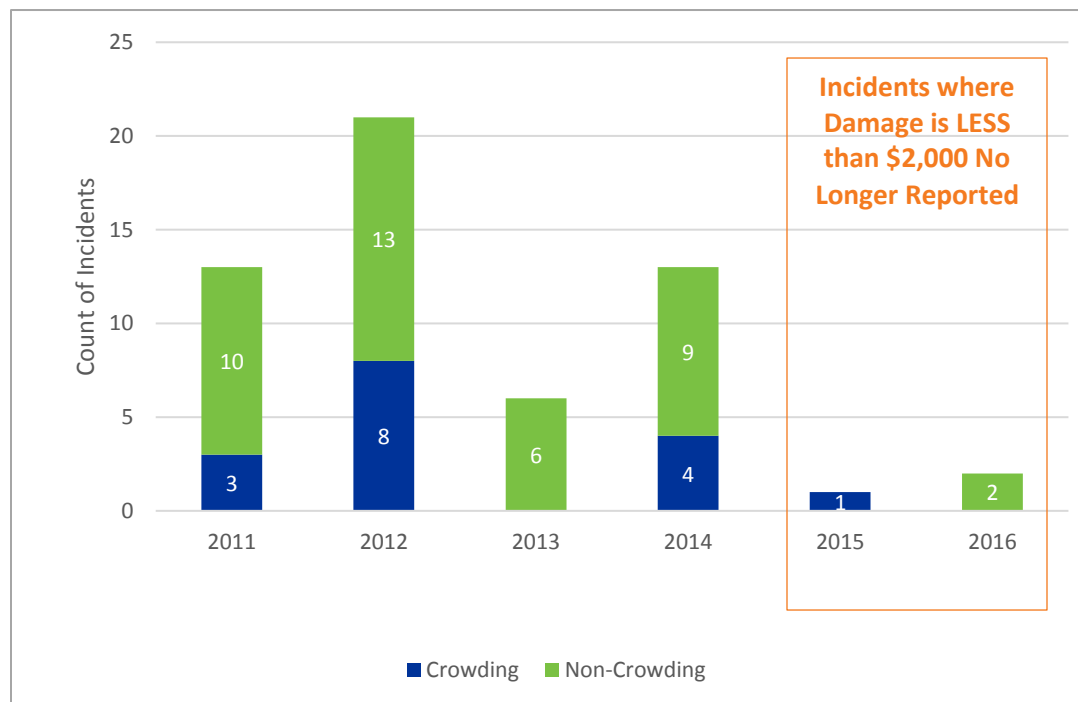


Figure 3-4. Crowding vs. Non-Crowding Incidents on Beaver Lake

Source: Arkansas Game and Fish Commission 2016

Of the 56 identified boating incidents on Beaver Lake over the past 6 years, 41 percent (23 incidents) occurred in Zone 3. Of the incidents in Zone 3, 30 percent (7 incidents) were related to crowding issues. In Zone 2, 60 percent of the 10 incidents reported during that same time are attributable to crowding. The proportion of incidents by zone and type is depicted in **Figure 3-5**. The 56 incidents on Beaver Lake were plotted spatially, as shown in **Figure 3-6**.

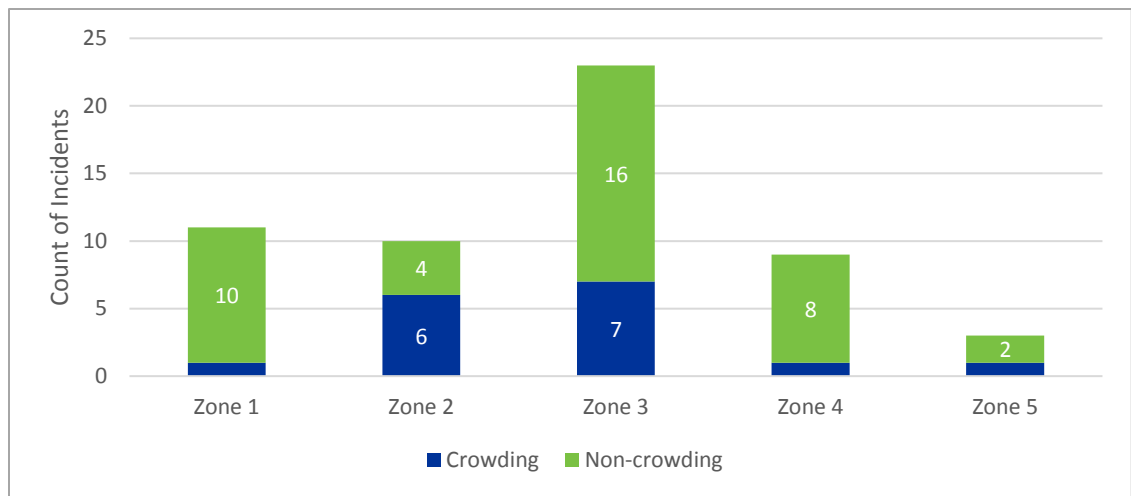


Figure 3-5. Boating Incidents by Study Zone (2011–2016)

Source: Arkansas Game and Fish Commission 2016; Study Zone derived using GIS analysis

Table 3-1. Crowding Incidents by Zone per 10,000 Useable Acres (2011–2016)

| Study Zone | Useable Acres | Crowding Incidents | Incidents Per 10,000 Useable Acres |
|------------|---------------|--------------------|------------------------------------|
| Zone 1 | 5,104 | 1 | 2.0 |
| Zone 2 | 5,473 | 6 | 11.0 |
| Zone 3 | 7,493 | 7 | 9.3 |
| Zone 4 | 4,051 | 1 | 2.5 |
| Zone 5 | 2,280 | 1 | 4.4 |
| Total | 24,401 | 16 | 6.6 |

The rate of crowding incidents per 10,000 useable acres was calculated to determine if more incidents occur in one zone or another when the data are normalized for zone area. As shown in **Table 3-1**, Zones 2 and 3 have significantly higher incident rates per 10,000 useable acres, 2 to 5 times more than Zones 1, 4, and 5. These data indicate that crowding-related incidents are much more likely to occur in Zone 2 and Zone 3 than other areas of Beaver Lake.

The timing component of boating incidents was also analyzed. As shown in **Figure 3-7**, 54 percent of incidents occurred on a Saturday or Sunday. Of the 55 incidents with a known time of day, 58 percent (32 incidents) occurred during the peak recreational boating time of 10 a.m. to 6 p.m. Nearly 90 percent of the incidents occurred during the peak summer months of May, June, July, August, and September (**Figure 3-8**).

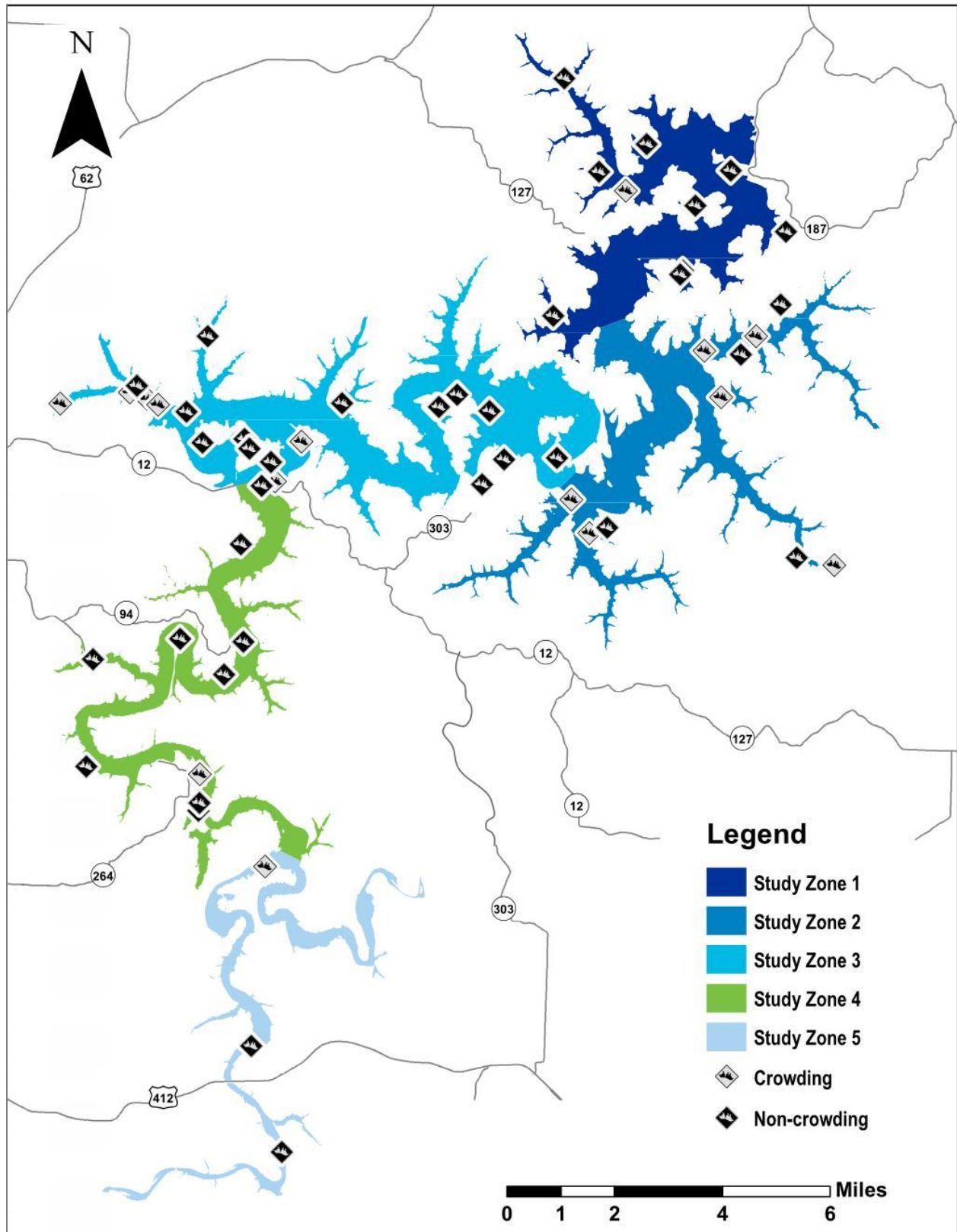


Figure 3-6. Map of Boating Incidents by Study Zone (2011–2016)

Source: GIS analysis of Arkansas Game and Fish Commission 2016 data

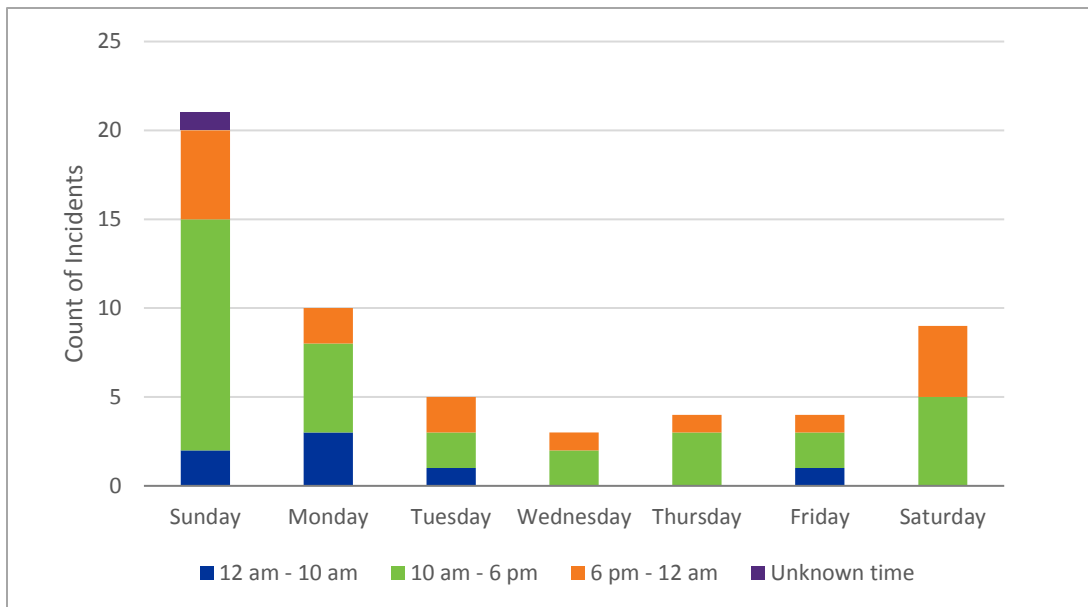


Figure 3-7. Boating Incidents by Day and Time

Source: Arkansas Game and Fish Commission 2016

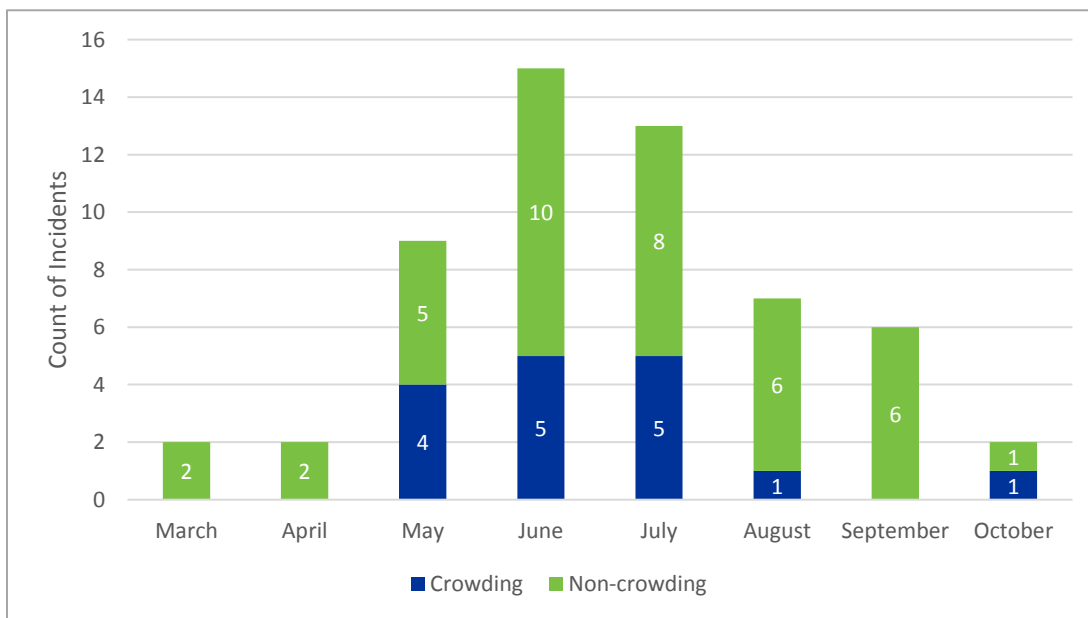


Figure 3-8. Boating Incidents by Month

Source: Arkansas Game and Fish Commission 2016

3.2.3 Comparison to Other Lakes

From 2011 to 2015, there were 350 boating incidents statewide across Arkansas (Arkansas Game and Fish Commission 2011–2015). Of these, 17 percent (59 incidents) occurred on Beaver Lake. The number of reported incidents on Beaver Lake as compared to the total reported lake incidents in Arkansas is shown in **Figure 3-9**. The most incidents occurred in 2012, with Beaver Lake accounting for 32 percent of all boating incidents in Arkansas that year. Compared to other lakes in Arkansas with high numbers of boating incidents, Beaver Lake had the highest number of boating incidents in 2011 and 2012, as shown in **Figure 3-10** (this comparison only included lakes with consistently high numbers of incidents over the

time period). The main causes of these incidents were operator inattention, followed by fault of machinery, reckless/negligent operation, and hazardous waters. *Note: The 2015 data indicate a noticeable decrease in incidents. However, recent legislative changes on reportable incidents increased the reporting amount from \$500 to \$2,000. Therefore, incidents where damage is less than \$2,000 are no longer reported (Arkansas Game and Fish Commission 2015), which may account for much of the reported decrease in 2015.*

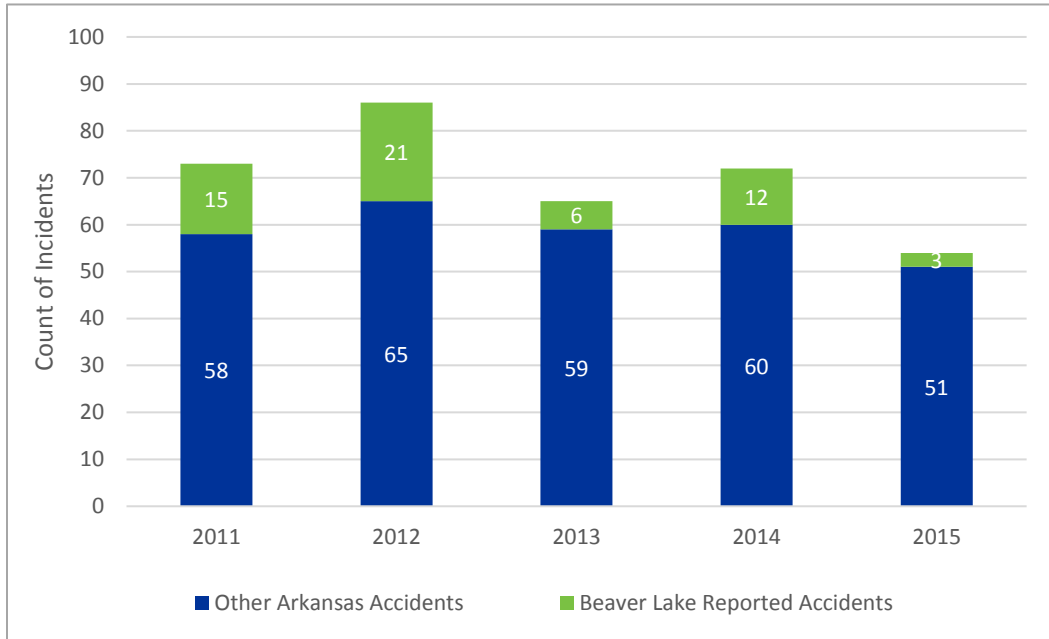


Figure 3-9. Incidents on Beaver Lake in Comparison to the Arkansas Statewide Total
 Source: Arkansas Game and Fish Commission 2011–2015

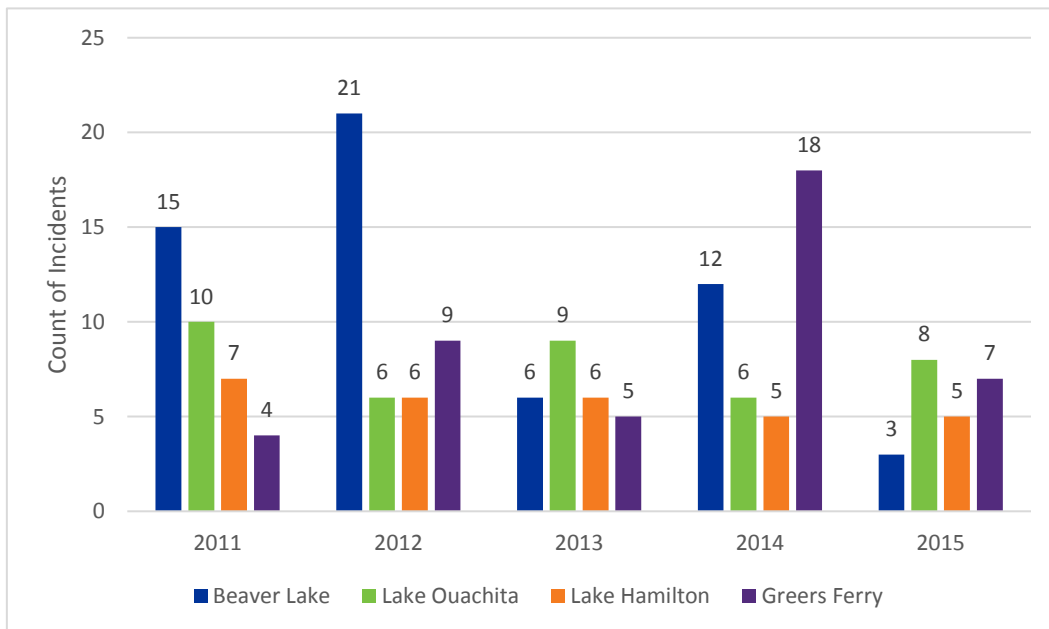


Figure 3-10. Comparison of Arkansas Lakes with Consistently High Numbers of Incidents
 Source: Arkansas Game and Fish Commission 2011–2015

Section 4

Current Boat Use Study and Results

A field survey was conducted to collect data on recreational boating lake use during four high-use summer weekends. Data were collected through aerial boat counts and simultaneous ground counts of empty boat trailers and empty marina slips. This information is utilized to determine the number and types of boats using the lake at any given time. The collected information also provides insights into boat origin and existing utilization levels of lake access facilities and infrastructure. This section describes the field survey methodology and resulting collected data and analysis.

4.1 Field Survey Methodology

The boat use and access study was conducted via field surveys that consisted of coordinated aerial and ground surveys boats on the water and access area use counts. The aerial team counted boats that were on the water at the same time that ground-based teams counted empty boat trailers at public boat launches and rented-but-empty marina slips. Counts were conducted in the morning and the afternoon on both Saturday and Sunday of four summer weekends during the 2016 recreation season. The field survey methodology is described in detail in Appendix D.

4.1.1 Aerial Boat Survey

Surveys were conducted over four weekends, including the Fourth of July weekend (July 2/3), two additional weekends in July (July 16/17 and July 23/24), and Labor Day weekend (September 3/4). Weather conditions prohibited helicopter operations during some survey periods over Fourth of July weekend and likely depressed boater turnout during other periods of that weekend. During the preparations, an alternate survey weekend was allotted for in the instance that an entire weekend was forecasted for rain. **Table 4-1** shows the planned survey dates and the alternate survey dates.

The weekend of July 9/10 was cancelled due to predicted rain, and the alternate survey schedule was implemented at USACE' direction. In addition, thunderstorms prevented a flyover from occurring the morning of July 3, and crew safety concerns resulted in a partial count on the morning of July 2.

Table 4-1. Primary and Alternate Field Survey Dates

| | Primary Survey Dates | Alternate Survey Dates |
|------------|----------------------|------------------------|
| Flyover #1 | July 2–3 | |
| Flyover #2 | July 9–10 | July 16–17 |
| Flyover #3 | July 16–17 | July 23–24 |
| Flyover #4 | Sept 2–3 | |

Two flyovers were attempted on each date as shown in **Table 4-2**, once in the morning (9 a.m. to noon) and once in the afternoon (1 to 4 p.m.). These flyovers were scheduled to coincide with the peak recreational use periods for the morning and the afternoons, respectively. Actual starting and ending

times are noted in the data tables found in Appendix D. The direction of travel (north to south or south to north) was varied (**Table 4-2**) so that the morning and afternoon counts were sampled equally in both directions.

Table 4-2. Planned Flyover Direction by Study Zone

| Day | A.M./P.M. | Flyover Sequence by Study Zone | | | | |
|------------------|-----------|--------------------------------|---|---|---|---|
| Weekend 1 | | | | | | |
| Saturday | a.m. | 1 | 2 | 3 | 4 | 5 |
| | p.m. | 5 | 4 | 3 | 2 | 1 |
| Sunday | a.m. | 5 | 4 | 3 | 2 | 1 |
| | p.m. | 1 | 2 | 3 | 4 | 5 |
| Weekend 2 | | | | | | |
| Saturday | a.m. | 5 | 4 | 3 | 2 | 1 |
| | p.m. | 1 | 2 | 3 | 4 | 5 |
| Sunday | a.m. | 1 | 2 | 3 | 4 | 5 |
| | p.m. | 5 | 4 | 3 | 2 | 1 |
| Weekend 3 | | | | | | |
| Saturday | a.m. | 1 | 2 | 3 | 4 | 5 |
| | p.m. | 5 | 4 | 3 | 2 | 1 |
| Sunday | a.m. | 5 | 4 | 3 | 2 | 1 |
| | p.m. | 1 | 2 | 3 | 4 | 5 |
| Weekend 4 | | | | | | |
| Saturday | a.m. | 5 | 4 | 3 | 2 | 1 |
| | p.m. | 1 | 2 | 3 | 4 | 5 |
| Sunday | a.m. | 1 | 2 | 3 | 4 | 5 |
| | p.m. | 5 | 4 | 3 | 2 | 1 |

During each flyover, two observers in the helicopter recorded the number, type of vessel, and recreational activity. The approximate location of each boat was noted on map sheets provided to record the data. In highly congested areas, the observers outlined the congested area and noted photograph numbers to allow for a tally to be made later. Another observer took photographs to assist in documenting the usage, density, and type of recreational activities observed (**Figure 4-1**).

The boating activity/boat types to be recorded were determined in coordination with USACE staff. Boats were tallied and recorded as falling into one of the following seven categories:

- Fishing/Bass
- Pontoon/Houseboat
- Skiing/Wake
- Speedboat
- Personal Watercraft
- Sailboat
- Canoe/Kayak



Figure 4-1. Congested Area of Beaver Lake, July 23 p.m. Flyover

Eight boat launch locations that are somewhat remote were identified to be surveyed from the air (shown on **Figure 4-2**). The helicopter crew flew over these locations during each aerial survey and took photographs of the parking areas so that the number of empty boat trailers could be counted. After the first two weekends, it was determined that the ground crews could more easily survey three of these launch sites, and Old Prairie Creek Road, Black Oak Drive, and Dam Site North Bluffs were eliminated from the helicopter flyover responsibilities.

4.1.2 Marina and Boat Ramp Survey

Ground-based field teams surveyed the boat ramps, marinas, and campgrounds around Beaver Lake at the same time periods as the helicopter flyovers. In coordination with USACE, the public boat launch access points to be surveyed were determined (**Figure 2-8** shows all boat launch locations at Beaver Lake, and **Figure 4-2** shows those that were surveyed for this study). All major public recreation areas and the primary public access points to the lake were surveyed, including all public boat ramps at campgrounds and marinas as well as several of the more popular public road ends. The recreation areas and access points included in the surveys are listed in **Table 4-3**. The number of empty boat trailers were counted at each boat launch area. All marinas (**Figure 2-7**) were visited during each survey period and the number of empty slips tallied.

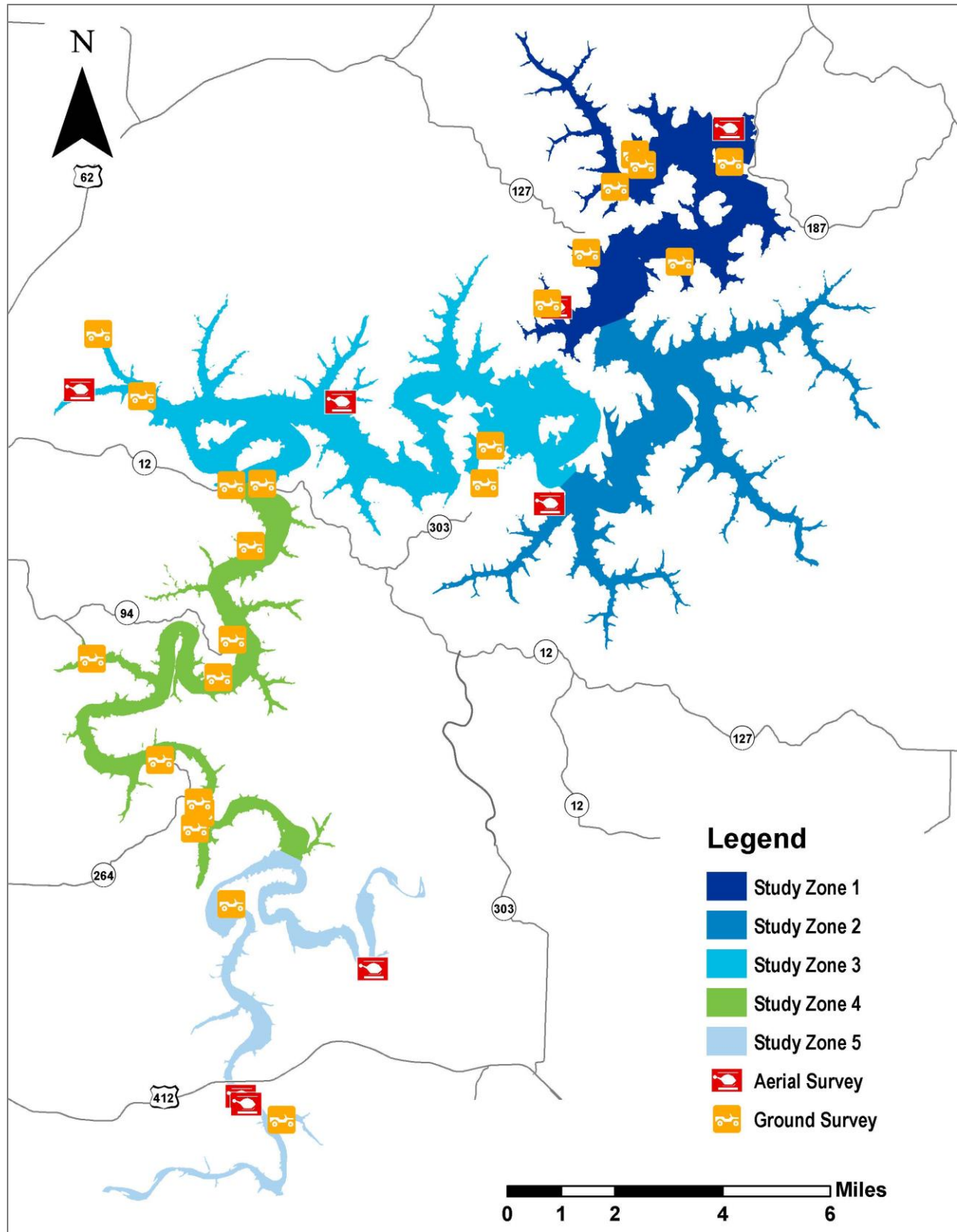


Figure 4-2. Boat Launches Surveyed

The areas to be surveyed were grouped and pre-set routes mapped to allow four two-person ground teams to cover the survey areas within the same time period as each helicopter flyover. The direction of travel for the ground teams (approximately north to south or south to north) mirrored the direction of helicopter travel for each survey period.

Table 4-3. Beaver Lake Recreation Facilities Included in Field Survey

| Location ¹ | Study Zone | Total Slips ² | Trailer Parking Spaces ³ |
|---------------------------------|------------|--------------------------|-------------------------------------|
| Beaver Lakefront Resort (R) | 2 | 6 | N/A |
| Beaver Shores (PR & RA) | 4 | N/A | 40 |
| Black Oak Drive (PR & RA) | 1 | N/A | 9 |
| Blue Springs (PR) | 5 | N/A | 16 |
| Camp War Eagle (R) | 5 | 12 | N/A |
| Clifty Park (PR) | 2 | N/A | 10 |
| Coppermine Lodge (R) | 3 | 28 | N/A |
| Dam Site Park (PR & C) | 1 | N/A | 30 |
| Dam Site North Park (PR) | 1 | N/A | 6 |
| Don Rouf/Hwy 412 (PR & RA) | 5 | N/A | 10 |
| Hickory Creek Park (PR & C) | 4 | N/A | 81 |
| Hickory Creek Marina (M) | 4 | 180 | 39 |
| Hide-A-Way Campground (R) | 2 | 6 | N/A |
| Horseshoe Bend Park (PR & C) | 4 | N/A | 30 |
| Horseshoe Bend Marina (M) | 4 | 160 | N/A |
| HWY 12 Ramp (PR & RA) | 4 | N/A | 48 |
| HWY 264 (RA) | 4 | N/A | 12 |
| Indian Creek Park (PR & C) | 1 | N/A | 10 |
| Jet Ski Beach (RA) | 4 | N/A | 15 |
| Lake Shore Cabins (R) | 1 | 8 | N/A |
| Lost Bridge North Park (PR & C) | 1 | N/A | 21 |
| Lost Bridge Marina (M) | 1 | 232 | N/A |
| Lost Bridge South Park (PR & C) | 1 | N/A | 15 |
| Monte Ne (PR & RA) | 4 | N/A | 15 |
| Natural Walk (PR & RA) | 5 | N/A | 15 |
| Old Prairie Creek Road (RA) | 3 | N/A | 10 |
| Prairie Creek Marina (M) | 3 | 733 | N/A |
| Prairie Creek Park (PR & C) | 3 | N/A | 177 |
| Rocky Branch Park (PR & C) | 3 | N/A | 41 |
| Rocky Branch Marina (M) | 3 | 307 | N/A |
| Starkey Park (PR & C) | 1 | N/A | 10 |
| Starkey Marina (M) | 1 | 156 | N/A |

| Location ¹ | Study Zone | Total Slips ² | Trailer Parking Spaces ³ |
|-------------------------------|------------|--------------------------|-------------------------------------|
| Twin Coves (PR & RA) | 2 | N/A | 15 |
| Twin Coves Resort (R) | 2 | 10 | N/A |
| Ventris Park (PR) | 3 | N/A | 10 |
| Ventris Trails End Resort (R) | 3 | 24 | N/A |
| War Eagle Park (PR & C) | 5 | N/A | 18 |
| War Eagle Marina (M) | 5 | 189 | N/A |
| White River Marine (RA) | 5 | 0 | 8 |

1. RA – Road Access Point; R – Resort; M – Marina; C – Campground; PR – Public Ramp

2. Marina and resort slip counts are based on field surveys and may not match other data sources.

3. **Bold** values indicate an estimated number of trailer parking spaces as provided by the Beaver Lake USACE Project Office staff.

Note: There are additional minor boat ramp areas that were not included in the field survey.

To determine the number of boats on the water from each marina location, the number of rented but empty boat slips at each marina was tallied. At marinas where there is a public boat ramp, the number of empty boat trailers in boat ramp parking lots was also counted. For each marina, the following information was collected:

- Number of slips currently rented
- Number of slips available for rent
- Number of empty but rented slips
- Number of vehicles with empty boat trailers

In addition to commercial marinas, resort operators were requested to self-report the number of boats departing from their docks during each of the survey periods. USACE coordinated with the resort owners who were provided with data sheets to record the information. Not all resort owners were able to participate, and one participated but the data were not in the requested format and could not be used. In total, four resorts provided useable data.

4.1.3 Marina Slip Vacancy Adjustment

As part of the process, the field team obtained the number of slips and the number of rented slips from each marina operator. During each survey period, the team counted the number of slips that were empty during each count and subtracted the number that were not rented (from the marina operator) to arrive at the number of boats on the lake from that marina.

During the initial survey periods, the teams noted that there were slips that were not only empty but which also appeared to have been unused for an extended period. For example, ground crews noted empty lifts covered with dust and cobwebs that might indicate that a rented slip is unoccupied and that the slip renter has pulled the boat off the lake for some reason. Boats may be used on a different lake during a specific weekend or for the summer or they may be removed from Beaver Lake for maintenance.

To arrive at an adjustment index to account for rented marina slips that are not occupied by a boat at Beaver Lake, the study team tracked empty slips by location on the last survey weekend of the field season (Labor Day weekend). A data form was developed where each slip along each dock in a marina was assigned a number. Slips that were empty were noted with an “X,” and slips that appeared to be unoccupied or unused for an extended period were noted with a “U.” These observations were tracked over the course of the entire weekend. Where the same slips were unoccupied for all four counts during a weekend, the likelihood increases that these slips are unused.

This information was considered in the analysis and the development of the point of access conclusions. The high end of the range assumes that all rented but empty slips represent a boat on the lake from a marina while the low end uses a value adjusted to account for slips that were unoccupied for an entire weekend. **Table 4-4** shows the data collected over the Labor Day weekend. These results indicate that approximately 6 percent of the rented marina slips could be vacant at any given time because a boat has been taken out for use at another lake or removed for maintenance.

Table 4-4. Marina Slip Vacancy Adjustment Factors

| Marina | Slips Marked “U” All Periods | Slips Marked “X” All Periods | Unrented slips | Rented and Vacant ¹ | Total rented slips | Percentage “off lake” ² |
|-----------------------|------------------------------|------------------------------|----------------|--------------------------------|--------------------|------------------------------------|
| Hickory Creek Marina | 4 | 9 | 0 | 13 | 180 | 7% |
| Horseshoe Bend Marina | 3 | 5 | 12 | 0 | 148 | 0% |
| Lost Bridge Marina | 7 | 14 | 0 | 21 | 232 | 9% |
| Prairie Creek Marina | 37 | 30 | 13 | 54 | 720 | 8% |
| Rocky Branch Marina | 27 | 12 | 27 | 12 | 280 | 4% |
| Starkey Marina | 1 | 10 | 0 | 11 | 156 | 7% |
| War Eagle Marina | 6 | 22 | 19 | 9 | 170 | 5% |
| Total | 85 | 102 | 71 | 120 | 1,886 | 6% |

1 – “Vacant slips” are the number of rented slips that were unoccupied for all four survey periods over the Labor Day weekend. All empty slips that were occupied for at least one of the survey periods are counted as a boat on Beaver Lake and are not included in this table.

2 – Percentage of unoccupied rented slips that may not represent a boat on the lake. This adjustment factor is applied to all survey weekends to calculate a lower end of boat activity from marinas on Beaver Lake.

4.2 Boat Type and Distribution Results

A total of 10,793 boats were tallied during the completed 14 aerial boat count survey periods. Of all the boats counted, 87 percent were power boats, and 13 percent were non-powered vessels. The most popular type of boat was skiing/wake boarding boat (40 percent), followed by pontoon/houseboat (26 percent), fishing/bass (12 percent), kayak/canoe (11 percent), personal watercraft (8 percent), sailboat (2 percent), and speedboat (1 percent). **Figure 4-3** shows the number of observed boats by type.

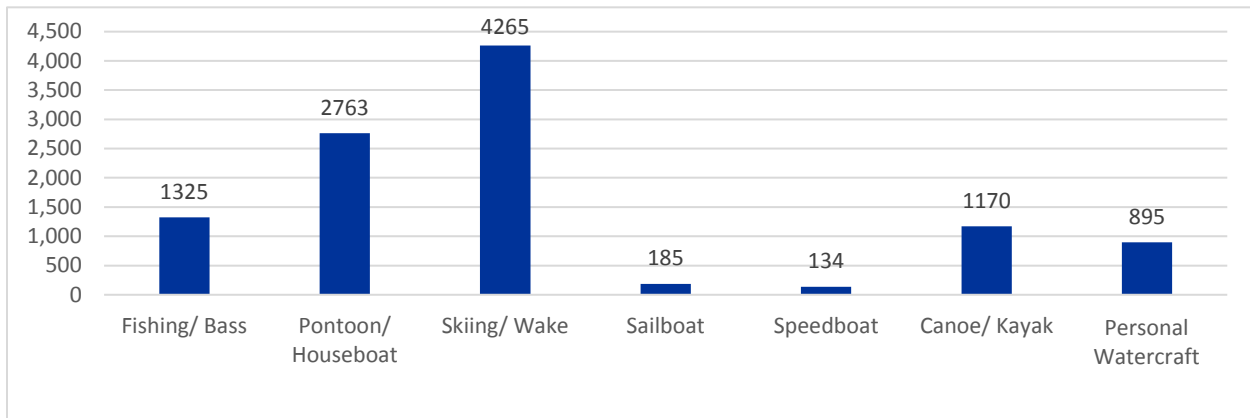


Figure 4-3. Number of Boats by Type

Boat counts ranged from 398 to 1,450, with afternoon counts consistently higher than morning counts. The greatest overall number of boats counted during any survey period was on the afternoon of September 4, 2016 when 1,450 boats were observed on the lake. Zone 3 was observed as having the highest boat count during the July 2 p.m. flyover. The boat counts by survey period and study zone are included in **Table 4-5**.

Table 4-5. Number of Boats by Survey Period and Study Zone

| Date | Time | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Total |
|--------------------|-------------|------------|------------|------------|------------|-----------|--------------|
| 2-Jul ¹ | a.m. | 71 | 49 | 65 | N/A | N/A | N/A |
| 2-Jul ³ | p.m. | 284 | 345 | 394 | 237 | 39 | 1,299 |
| 3-Jul ² | a.m. | N/A | N/A | N/A | N/A | N/A | N/A |
| 3-Jul ³ | p.m. | 102 | 118 | 163 | 145 | 66 | 592 |
| 16-Jul | a.m. | 175 | 85 | 143 | 152 | 56 | 611 |
| 16-Jul | p.m. | 197 | 274 | 296 | 233 | 22 | 1,022 |
| 17-Jul | a.m. | 101 | 43 | 93 | 117 | 35 | 389 |
| 17-Jul | p.m. | 153 | 171 | 295 | 183 | 46 | 848 |
| 23-Jul | a.m. | 72 | 48 | 157 | 135 | 41 | 453 |
| 23-Jul | p.m. | 213 | 331 | 301 | 204 | 47 | 1,096 |
| 24-Jul | a.m. | 145 | 62 | 94 | 77 | 20 | 398 |
| 24-Jul | p.m. | 146 | 152 | 212 | 172 | 52 | 734 |
| 3-Sep | a.m. | 120 | 47 | 89 | 95 | 36 | 387 |
| 3-Sep | p.m. | 164 | 210 | 187 | 187 | 51 | 799 |
| 4-Sep | a.m. | 123 | 63 | 116 | 131 | 43 | 476 |
| 4-Sep | p.m. | 297 | 455 | 369 | 261 | 68 | 1,450 |

1 – Due to safety considerations, aerial survey was aborted. Zones 1 and 2 were completed, Zone 3 was partially completed, and Zones 4 and 5 were not surveyed.

2 – Due to thunderstorms, the aerial survey was cancelled.

3 – 4th of July weekend experienced rainy conditions, and survey times may have underestimated boating.

Values in **BOLD** represent the maximum number of boats observed for the study zone and lake overall.

Overall, for the 14 survey periods, Zone 3 tallied the most number of boats, with 2,935 (excluding counts on the morning of July 2), followed by Zone 4 with 2,294. Zones 1 through 4 each totaled between 21 and 28 percent of the total number of boats. A significantly fewer number of boats was observed in Zone 5 (6 percent). Total boat counts and the percent of total boats by study zone are shown in **Figure 4-4**.

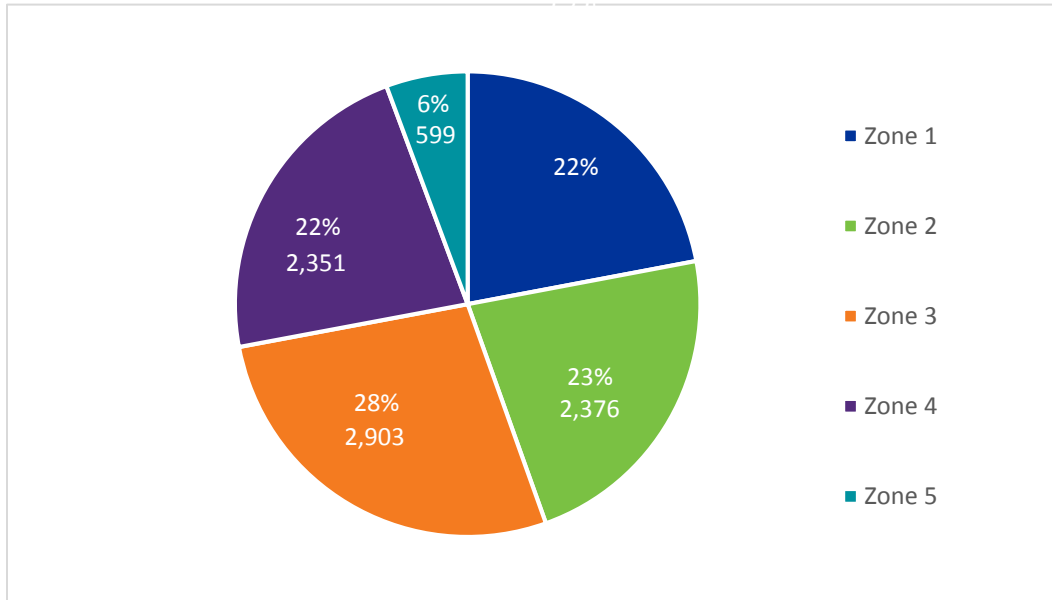


Figure 4-4. Count and Percent of Total Boats Surveyed by Study Zone

More boats were observed on the lake in the afternoon survey periods than in the morning periods (**Figure 4-5**). However, boat type was not consistently distributed between the morning and afternoon periods. Fishing/bass boats were more common in the mornings than in the afternoon while sailboats and speedboats were almost never encountered in the mornings. Ski boats were five times more likely to be out on the lake in the afternoon than in the mornings.

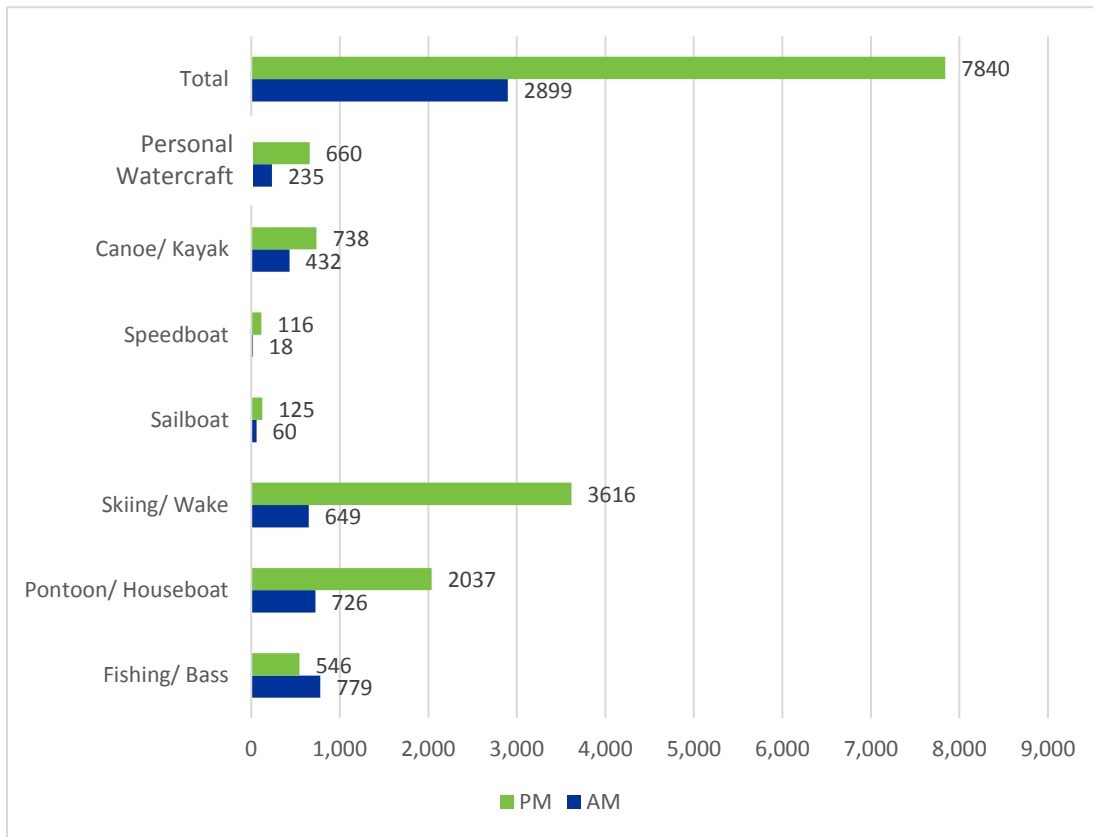


Figure 4-5. Boat Type by Morning and Afternoon Field Survey Periods

The type of vessel and associated recreational activity varied between study zone. Skiing/wake boats were the most common type of boat observed in Zones 1, 2, and 3. In Zone 4, 36 percent of the boats were pontoon/houseboats, and in Zone 5, fishing/bass boats were the most common at 41 percent of all boats observed within that zone (Table 4-6). Figure 4-6 displays boat type by study zone.

Table 4-6. Distribution of Boat Type within Each Study Zone

| Study Zone | Fishing/ Bass | Pontoon/ Houseboat | Skiing/ Wake | Sailboat | Speedboat | Canoe/ Kayak | Personal Watercraft |
|------------|---------------|--------------------|--------------|----------|-----------|--------------|---------------------|
| Zone 1 | 8% | 28% | 33% | 5% | 1% | 13% | 12% |
| Zone 2 | 6% | 20% | 52% | 1% | 4% | 10% | 6% |
| Zone 3 | 10% | 22% | 49% | 1% | 1% | 10% | 7% |
| Zone 4 | 18% | 36% | 28% | 0% | 0% | 10% | 8% |
| Zone 5 | 41% | 18% | 17% | 0% | 0% | 14% | 9% |

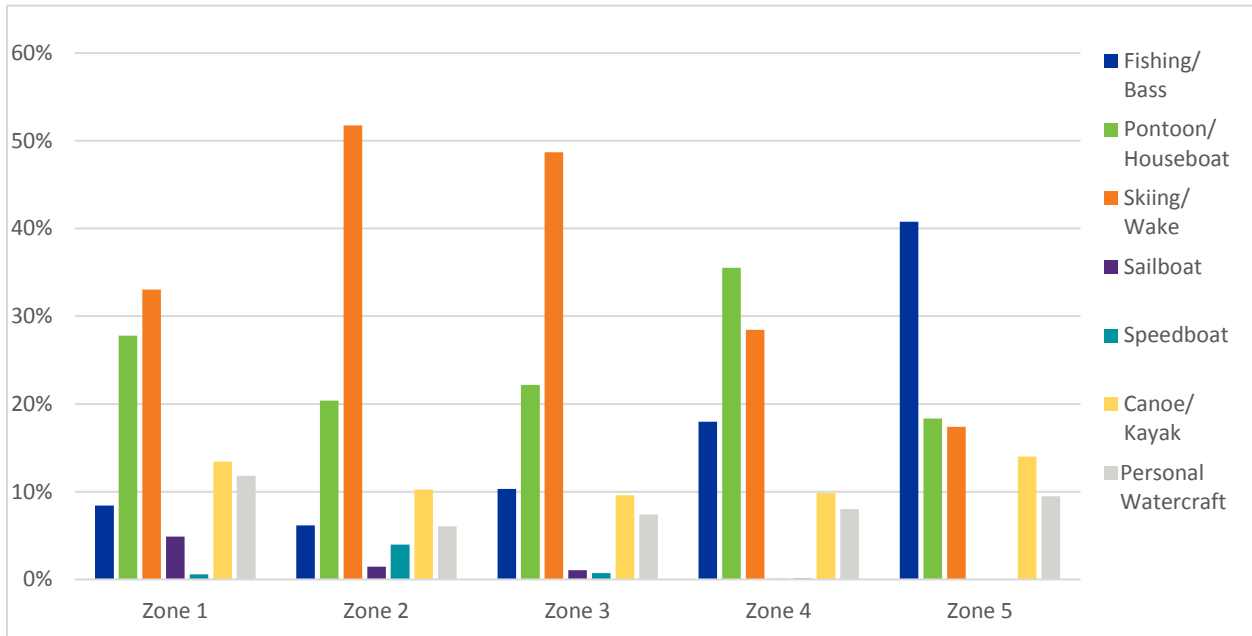


Figure 4-6. Boat Type by Study Zone

An alternative way to view the data is to consider how each boat type is distributed across the lake. However, because each study zone is a different size, this distribution is adjusted to account for the relative size of the study zone, which provides a uniform basis for comparison of percent use by study zone. **Table 4-7** shows that of all the fishing boats, 12 percent were found in Zone 1, 9 percent were found in Zone 2, and so on.

Table 4-7. Distribution of Each Boat Type by Study Zone, Weighted for Zone Area

| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 |
|---------------------|--------|--------|--------|--------|--------|
| Fishing/Bass | 12% | 9% | 13% | 33% | 33% |
| Pontoon/Houseboat | 23% | 18% | 24% | 31% | 4% |
| Skiing/Wake | 18% | 30% | 34% | 16% | 2% |
| Sailboat | 62% | 19% | 18% | 1% | 0% |
| Speedboat | 10% | 72% | 16% | 2% | 0% |
| Canoe/Kayak | 27% | 21% | 25% | 20% | 7% |
| Personal Watercraft | 31% | 17% | 25% | 21% | 6% |
| All Boats | 22% | 23% | 28% | 22% | 6% |

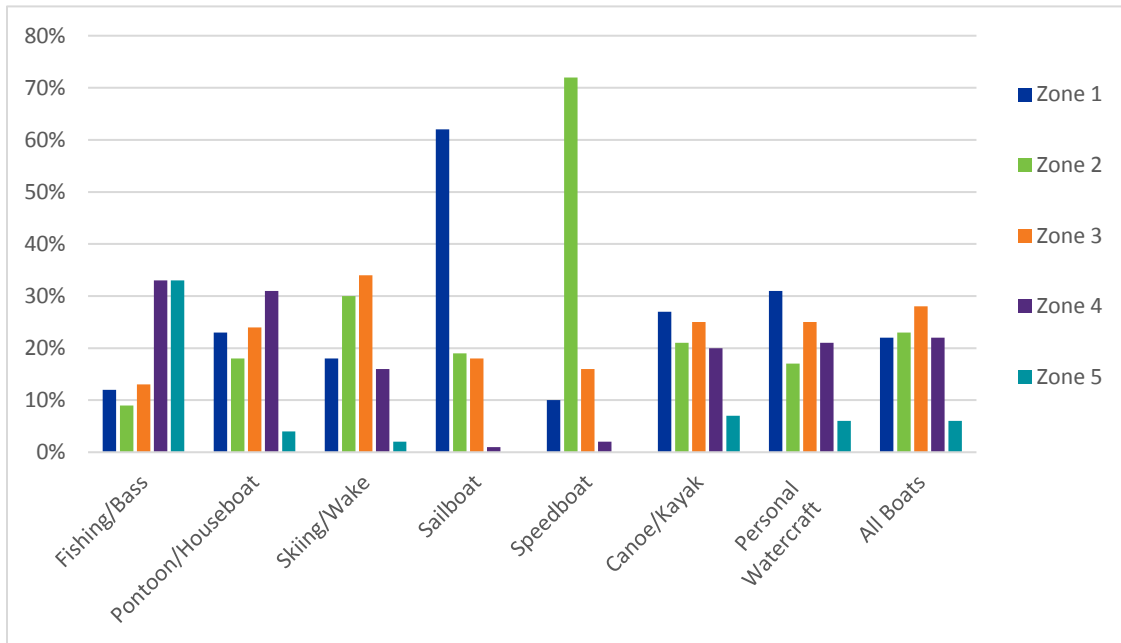


Figure 4-7. Boat Type Distribution across Study Zones Weighted for Zone Area

Figure 4-7 shows the distribution of each boat type across the five study zones. The chart more clearly shows where boat types occur preferentially in one or two lake zones. The difference in occurrence in Zone 5 as compared to other study zones for all boat types is statistically significant. The differences in the distribution of ski boats and fishing boats is particularly striking. Skiing boats are significantly more likely to be found in Zones 2 and 3 than in other lake zones. Fishing boats are more likely to be found in Zones 4 and 5.

4.3 Observed Peak Boat Density

The observed peak boating density for Beaver Lake is calculated by dividing the useable water surface acres by the boat count from the survey period that tallied the most number of boats:

$$\text{Observed Peak Density} = 24,401 \div 1,450 = 16.8 \text{ useable acres per boat}$$

Table 4-8 shows the *Observed Peak Density by Zone* from the collected field data. For Zones 1, 2, 4, and 5, the greatest number of boats were observed during the September 4 p.m. flyover of Labor Day weekend. For Zone 3, the greatest number of boats was observed during the July 2 p.m. flyover of the Fourth of July holiday weekend. Zone 2 was observed as having the greatest density of boats at 12 useable acres per boat followed Zone 4 at 15.5 useable acres per boat.

Table 4-8. Observed Peak Boat Density by Study Zone

| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Total |
|-------------------------------|--------|--------|--------|--------|--------|--------|
| Useable Acres | 5,104 | 5,473 | 7,493 | 4,051 | 2,280 | 24,401 |
| Maximum Number Observed Boats | 297 | 455 | 394 | 261 | 68 | 1,450 |
| Useable Acres per Boat | 17.2 | 12.0 | 19.0 | 15.5 | 33.5 | 16.8 |

4.4 Boat Origination Results

Boaters can access Beaver Lake from various infrastructure and facilities: public boat ramps, marina slips, or private, community, and resort docks. The presumption was that one empty boat trailer equals one boat on the lake originating from the public access point where the trailer was observed. Similarly, an empty but rented marina slip represents one boat on the lake and the marina location provides the origination location for those boats. From this information, the number of boats on the water from private, community, and resort docks can be derived.

4.4.1 Public Access Ramp Results

According to data provided by USACE, there are a total of 711 trailer parking spaces located in recreation areas where empty boat trailer counts were conducted (**Table 4-9**). This represents officially designated parking spaces at facilities where trailer parking spaces are marked and estimated values at areas where trailer parking spaces are not marked (i.e., end of the road access points). A total of 4,795 empty boat trailers were tallied during all survey periods. The percentage of empty boat trailers by study zone are shown in **Figure 4-8**. These percentages represent the origination location for the boats on the water from each study zone for all survey periods.

Table 4-9. Available Trailer Parking Spaces by Study Zone

| Study Zone | Trailer Parking Spaces |
|------------|------------------------|
| Zone 1 | 101 |
| Zone 2 | 25 |
| Zone 3 | 238 |
| Zone 4 | 280 |
| Zone 5 | 67 |
| Total | 711 |

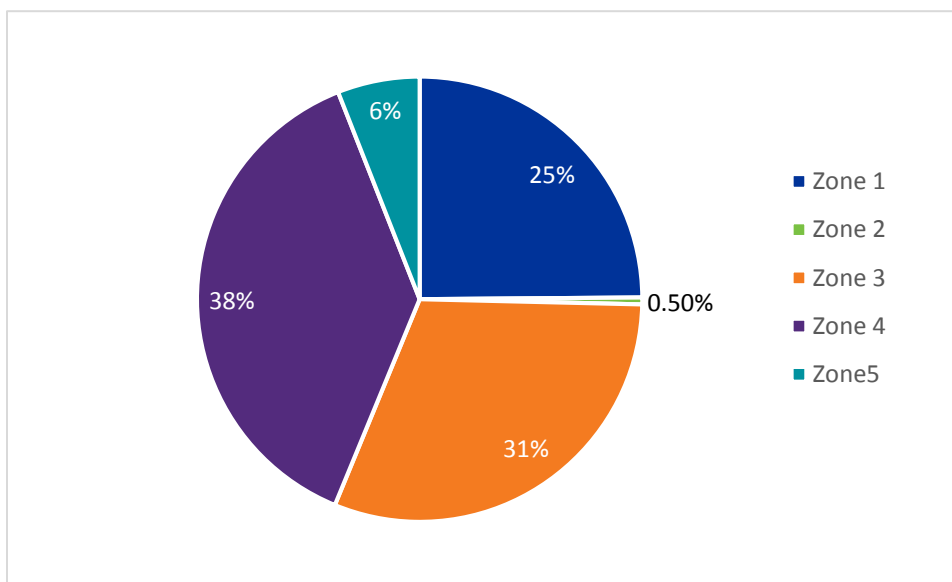


Figure 4-8. Empty Boat Trailers by Study Zone

Empty boat trailer counts for each lake area and survey period are included in **Table 4-10**. Overall, boat ramps at Beaver Lake operated at 48 percent of total capacity on average during the field survey. Maximum usage of 90 percent of total capacity was recorded on July 2 during the afternoon survey. For some facilities, however, capacity exceeded 100 percent at times as boat trailers were observed in non-designated parking areas or in car parking spaces. Peak capacity use rate varied by study zone. Zone 1 experienced a peak of 151 percent of capacity. Zone 3 experienced 93 percent of capacity, followed by Zone 4 at 85 percent, Zone 5 at 49 percent, and Zone 2 at 32 percent. The geographic proximity of Zone 2 likely accounts for its low use rate, as it is the furthest distance from the Fayetteville-Springdale-Rogers MSA.

Table 4-10. Empty Boat Trailers by Survey Period and Study Zone

| Date | Time Period | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Total | Percent Capacity ² |
|---|-------------|--------------|------------|--------------|--------------|------------|--------------|-------------------------------|
| 2-Jul | a.m. | 75 | 0 | 55 | 116 | 10 | 256 | 36% |
| 2-Jul | p.m. | 153 | 8 | 221 | 238 | 18 | 638 | 90% |
| 3-Jul | p.m. | 45 | 1 | 33 | 76 | 13 | 168 | 24% |
| 16-Jul | a.m. | 51 | 1 | 90 | 102 | 19 | 263 | 37% |
| 16-Jul | p.m. | 98 | 2 | 155 | 142 | 22 | 419 | 59% |
| 17-Jul | a.m. | 51 | 2 | 38 | 76 | 15 | 182 | 26% |
| 17-Jul | p.m. | 79 | 0 | 114 | 161 | 13 | 367 | 52% |
| 23-Jul | a.m. | 54 | 0 | 66 | 73 | 18 | 211 | 30% |
| 23-Jul | p.m. | 122 | 2 | 167 | 153 | 19 | 463 | 65% |
| 24-Jul | a.m. | 42 | 2 | 49 | 70 | 14 | 177 | 25% |
| 24-Jul | p.m. | 76 | 1 | 89 | 92 | 20 | 278 | 39% |
| 3-Sep | a.m. | 54 | 0 | 59 | 85 | 20 | 218 | 31% |
| 3-Sep | p.m. | 102 | 2 | 100 | 126 | 19 | 349 | 49% |
| 4-Sep | a.m. | 54 | 1 | 52 | 100 | 17 | 224 | 32% |
| 4-Sep | p.m. | 148 | 3 | 200 | 198 | 33 | 582 | 82% |
| Total | | 1,204 | 25 | 1,488 | 1,808 | 270 | 4,795 | 48% |
| Percent Capacity by Study Zone³ | | 151% | 32% | 93% | 85% | 49% | | |

Notes: The number of empty boat trailers tallied during each survey period includes empty boat trailers located in designated trailer spaces, empty boat trailers located in undesignated locations, and empty boat trailers located within campgrounds adjacent to the boat ramps where surveys were conducted. One empty boat trailer equals one boat on the lake from a public access point.

2. Percent of Capacity is the percent of the total available trailer parking spaces for boat trailers (711) against the number of spaces that were occupied during the survey period.

3. Available trailer parking spaces by study zone is found in Table 4-9.

4.4.2 Marina Slip Survey Results

There are seven commercial concession marinas located on Beaver Lake that contain a total of 1,957 slips as counted during the field surveys. The overall occupancy rate for all marinas at the time the marina surveys were conducted was 96 percent. **Table 4-11** identifies usage information for each marina at the time of the survey. **Table 4-12** identifies the total number of slips and rental rates by study zone. Slip rental information was obtained from each marina operator at the time of the field surveys. There are no marinas located in Zone 2.

Table 4-11. Marina Slip Information

| Marina | Zone | Total Slips ¹ | Slips Rented | Percent Rented |
|-----------------------|------|--------------------------|--------------|----------------|
| Hickory Creek Marina | 4 | 180 | 180 | 100% |
| Horseshoe Bend Marina | 4 | 160 | 148 | 93% |
| Lost Bridge Marina | 1 | 232 | 232 | 100% |
| Prairie Creek Marina | 3 | 733 | 720 | 98% |
| Rocky Branch Marina | 3 | 307 | 280 | 91% |
| Starkey Marina | 1 | 156 | 156 | 100% |
| War Eagle Marina | 5 | 189 | 170 | 90% |
| Total | | 1,957 | 1,886 | 96% |

1. The total number of slips is based on the survey field observations and may not conform to other data sources.

Table 4-12. Marina Slip Information Summarized by Study Zone

| Zone | Total Slips | Slips Rented | Percent Rented | Slip Vacancy Adjustment Factor ¹ |
|-------|-------------|--------------|----------------|---|
| 1 | 388 | 388 | 100% | 8 % |
| 2 | 0 | 0 | N/A | N/A |
| 3 | 1,040 | 1,000 | 96% | 7 % |
| 4 | 340 | 328 | 96% | 4 % |
| 5 | 189 | 170 | 90% | 5 % |
| Total | 1,957 | 1,886 | 96% | 6 % |

1. Slip vacancy adjustment factor accounts for boats that may be in use at a lake other than Beaver Lake or off the lake for maintenance. See Section 4.1.3 for an explanation.

Data from each of the survey periods are summarized in **Table 4-13**. This analysis presents the following conclusions:

- For all survey periods, approximately 5,633 boats on the water originated from marina slips assuming every rented slip had a boat occupying it during the field surveys. When the marina vacancy adjustment factor is applied, approximately 388 apparent boats are likely on lakes other than Beaver Lake or out of the water for maintenance. This leaves an adjusted estimation of 5,295 boats on Beaver Lake from marinas during all survey periods.
- Over all survey periods, the greatest number of boats originating from marinas occurred on July 2 during the afternoon survey when 556 are estimated as being on the water from marinas.

Table 4-13. Boats Originating from Marinas by Survey Period

| Date | Time Period | Boats on the Water from Marina Slips (high) ¹ | Slip Vacancy Adjustment Factor | Boats on the Water from Marina Slips (low) ² |
|--------------|-------------|--|--------------------------------|---|
| 2-Jul | a.m. | 309 | 19 | 290 |
| 2-Jul | p.m. | 591 | 35 | 556 |
| 3-Jul | p.m. | 304 | 18 | 286 |
| 16-Jul | a.m. | 319 | 19 | 300 |
| 16-Jul | p.m. | 461 | 28 | 433 |
| 17-Jul | a.m. | 280 | 17 | 263 |
| 17-Jul | p.m. | 465 | 28 | 437 |
| 23-Jul | a.m. | 308 | 18 | 290 |
| 23-Jul | p.m. | 444 | 27 | 417 |
| 24-Jul | a.m. | 269 | 16 | 253 |
| 24-Jul | p.m. | 403 | 24 | 379 |
| 3-Sep | a.m. | 273 | 16 | 257 |
| 3-Sep | p.m. | 396 | 24 | 372 |
| 4-Sep | a.m. | 279 | 17 | 262 |
| 4-Sep | p.m. | 532 | 32 | 500 |
| Total | | 5,633 | 338 | 5,295 |

1. The higher tally of boats on the water from marina slips is from the actual count of empty slips before adjusting for vacancies (vacant rented slips that do not represent a boat on Beaver Lake during the survey).

2. The lower tally of boats on the water from marinas is adjusted by the slip vacancy adjustment factor of 6 percent.

4.4.3 Resort Results

Resort owners/operators were requested to self-report the number of boats departing from their docks during each of the survey periods. The resorts were asked to report the number of rented or occupied boat slips that were currently empty, which assumes that boat was on the water at the given survey period. Not all resort owners were able to participate, and one participated but the data were not in the requested format and could not be used. In total, four resorts provided useable data.

Analysis of the data provided by the four resorts reveals that the use rate of resort boat slips ranged from a low of 10 percent on the morning of July 23 to a high of 38 percent on both the afternoons of July 2 and July 17. Average over the survey period was a 27 percent use rate. The lake use rate indicates that every 100 resort slips would generate, on average, approximately 27 boats on the water at one time and up to 38 boats at one time during peak use periods.

4.4.4 Public and Community Dock Origination

The origination source for boating activity on Beaver Lake was estimated by combining and analyzing data from the various field survey data collections. The number of empty boat trailers from boat ramp and campground parking lots was added together with the number of rented but empty marina slips from the marina survey to determine the origination location for boats on the water during the survey periods. When the sum of this data is subtracted from the boat counts from the aerial boat counts, the number of boats on the water that originated from private, community, and resort docks can be

estimated. This calculation was executed for the afternoon surveys only, as shown in **Table 4-14**, as early morning survey periods experienced a high level of boaters in transit and are not useful in providing accurate estimates of private and community dock boat origination. Note: Actual self-report resort counts were not considered in this calculation since the data were partial. Rather, the estimated value represents private, community, and resort docks. This assumption is carried forth in the remainder of the document.

On average, 15 percent of boats on the water during the afternoon counts can be attributed to private, community, and resort boat docks. The 8 percent estimated value for the July 2 afternoon flyover may be representative of the actual count but may be underestimated for the peak of that day. Fireworks started that evening after dark, and the peak may have occurred later in the afternoon, and a high number of boaters may have been in transit during the time of the count. The greatest number of boats from private, community, and resort boat docks is from the September 4 afternoon flyover where a total of 368 boats, or 25 percent of the total, are estimated to have originated from this source.

Table 4-14. Boats Originating from All Facilities for Afternoon Survey Periods

| Date | Time Period | Total Boats Counted by Aerial Team a. | Empty Trailers b. | Marina Slips (adjusted) c. | Boats from Private, Community, and Resort Docks (Derived) ¹ d. | Percent from Private, Community, and Resort Docks |
|--------|-------------|--|----------------------|-------------------------------|--|---|
| 2-Jul | p.m. | 1,299 | 638 | 556 | 105 | 8% |
| 3-Jul | p.m. | 592 | 168 | 286 | 138 | 23% |
| 16-Jul | p.m. | 1,022 | 419 | 433 | 170 | 17% |
| 17-Jul | p.m. | 848 | 367 | 437 | 44 | 5% |
| 23-Jul | p.m. | 1,096 | 463 | 417 | 216 | 20% |
| 24-Jul | p.m. | 734 | 278 | 379 | 77 | 10% |
| 3-Sep | p.m. | 799 | 349 | 372 | 78 | 10% |
| 4-Sep | p.m. | 1,450 | 582 | 500 | 368 | 25% |

1. Boats from private, community, and resort boat docks calculated as: $d = a - b - c$.

4.4.5 Boat Origination Summary

Data from **Table 4-14** are used to summarize the average boat origination percent for boat ramps, marina slips, and private, community, and resort docks. On average, for the afternoon flyovers, approximately 42 percent of the boats on the water during the survey periods came from boat ramps and 43 percent from marina slips. An estimate 15 percent of the boats on the lake can be attributed to private, community, and resort docks. **Figure 4-9** displays boat origination summary by facility type. Note: Slips associated with sailing clubs are included with the private, community, and resort dock slips.

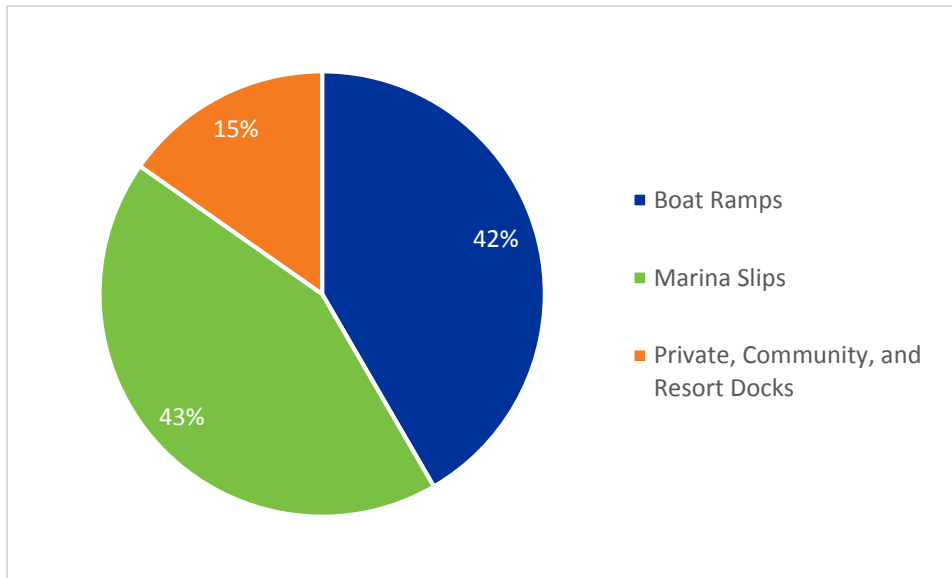


Figure 4-9. Average Boat Origination by Facility Type

4.5 Peak Holiday Use

Memorial Day weekend, the traditional start of the summer season, is an especially busy weekend at Beaver Lake. This contract to initiate this survey was not in place until mid-June 2016; thus this survey did not capture the boating use patterns over Memorial Day weekend. However, USACE rangers did count the number of empty boat trailers at seven locations during the early afternoon at seven of the busier boat launches over the Memorial Day weekend and through the initiation of the study. USACE conducted the trailer counts during the July 23/24 weekend as well. This allowed USACE counts to be compared to the number of trailers counted during study weekends, assuring a reasonable comparison. Data were pulled for those seven locations for all study weekends to determine if missing the Memorial Day weekend or earlier summer weekends in June could have resulted in underestimating peak use at Beaver Lake.

Comparing the number of empty trailers observed by USACE and by the survey teams in the afternoons revealed that the Fourth of July weekend (July 2 afternoon count) had the greatest numbers of empty trailers at the seven locations than any other survey period. Thus, the peak holiday weekend was likely surveyed during this study.

4.6 Field Survey Limitations

The survey method was designed to capture a range of boating conditions and activities. By conducting two surveys each day, the survey gathered data about users who may be more interested in fishing or a quieter or perhaps cooler experience as well as those interested in more active water sports or using the lake during the hotter part of the day. The survey times were selected in consultation with lake managers to capture the peak times for users across the spectrum of user types.

It is possible that the 9 a.m. start time underestimated use by fishermen who may go out very early in the day or even with first light. At several locations, surveyors encountered boaters coming off the water at 9 a.m. just as the survey was starting. Similarly, in the summer when the days are long, it is

possible that many afternoon boaters may not get out onto the water until after 3 or 4 p.m. when most surveys were completed and thus would not be counted. This may have been especially true on July 2 when many boaters went out onto the water late in the day to watch an evening fireworks display near Prairie Creek.

Although each survey period is intended to be a point in time snapshot of activity on the lake, it is not truly instantaneous. During the 2- to 3-hour period for each survey, boats would enter and exit the lake and boats would move around the lake from place to place. The lake was sampled each time within a relatively short window (2 to 3 hours), which minimizes the effect of this potential source of variation in the counts, but this error cannot be eliminated. Times when many boaters were in transit bring uncertainty in estimating boat origination. The use of a helicopter allowed for much faster recording of boats on each segment of the lake than would be possible from another location such as from another boat. The helicopter crew learned to note the speed and direction of boats that were close to a survey zone boundary. Then as the helicopter circled over a zone or went down an arm and returned to the boundary vicinity, they could avoid double counting boats that would have moved in the intervening few minutes. The use of the helicopter also allowed for complete coverage of the lake. The helicopter team was able to efficiently fly over the ends of narrow coves where boats would tie up for a quiet retreat or where rafts of boats would link up for a summertime party. These remote corners of the lake were included in these survey results, thus, making the results more robust.

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Section 5

Boater Perceptions on Crowding and Safety

The existing social carrying capacity was assessed through administration and analysis of a survey to a sample of boaters who participate in on-water recreation activities at Beaver Lake. The purpose of the survey was to gather information on user experiences, perceptions, and preferences in regards to crowding and boating safety. The goals of the survey were to:

- Determine the general characteristics of lake users
- Determine the impact of current lake usage on the quality of the recreational experience, public safety, and the natural ecology of the lake
- Determine boaters' perspectives on the social conditions of the lake and on current resource management of the lake

This section provides key results from the survey on social perceptions of safety and crowding. Appendix B provides details on the development, administration, and full results of the boater survey.

5.1 Safety

The majority of respondents indicated that they feel that boating conditions are very to extremely safe (64 percent), with the remaining 36 percent noting some concern for boating safety. The top 15 safety issues noted are summarized in **Figure 5-1**. The top issue was uneducated/inexperienced boaters, with 10 percent of the respondents writing in a response such as this. High-speed cigarette and wake boats were noted as a safety concern by 9 percent of the respondents. Crowding on holidays and weekends as well as crowding at Prairie Creek were among the other top responses.

When asked a different way, 58 percent of respondents indicated they feel that the number of boats on Beaver Lake is creating a safety problem (**Figure 5-2**). Thirty-six percent indicated that the problem is slightly serious, and 18 percent indicated the problem is moderately serious.

A difference was noted in responses by residency. Those residents who indicated their home is located along the shoreline of Zone 1 were much more likely to say boating conditions are very or extremely safe (73 percent), and residents located in Zone 4 were less likely to say boating conditions are very or extremely safe (55 percent). Residents of Zone 4 were also least likely to say that safety was “*not at all*” a problem.

There are also significant differences in perceptions of safety by the primary type of boat used at the lake. Those that use personal watercrafts, cabin cruisers, or houseboats are most likely to say that boating at the lake is very or extremely safe (78, 74, and 73 percent, respectively). Those that use rowboats, sailboats, or fishing boats are least likely to say that conditions are very or extremely safe (50, 55, and 54 percent, respectively).

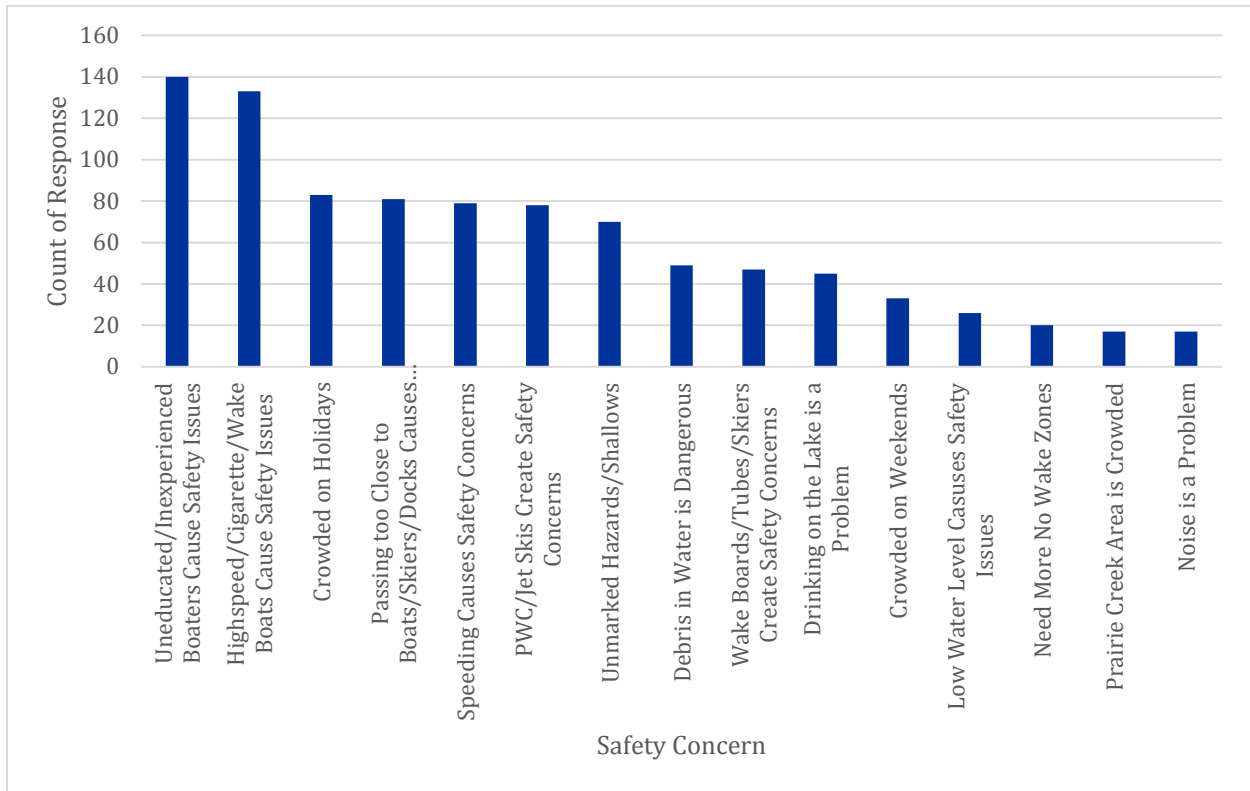


Figure 5-1. Top 15 Safety Concerns

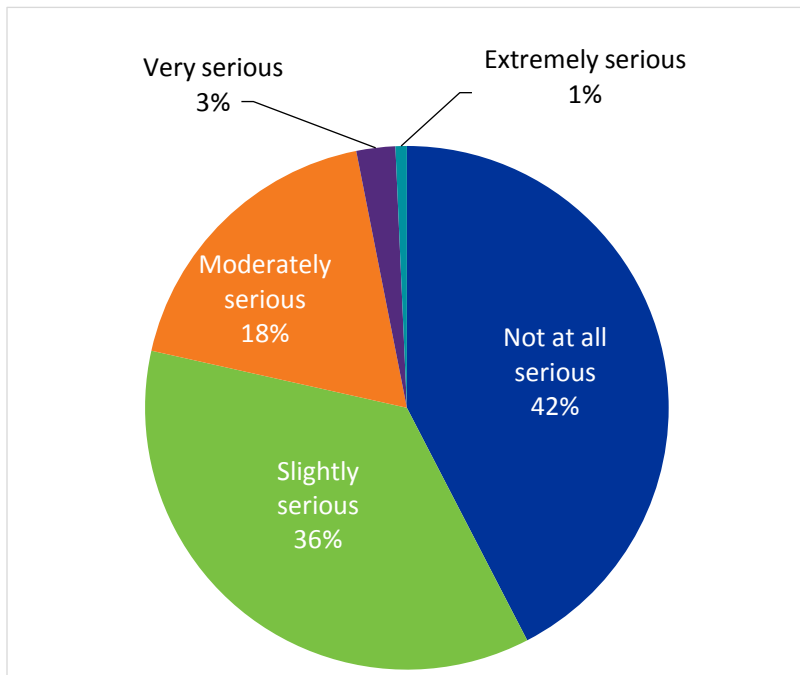


Figure 5-2. Seriousness of a Safety Problem from the Number of Boats

When asked how safe boating conditions are on Beaver Lake, boaters who primarily recreate in Zone 3 and Zone 4 are more likely to indicate safety issues (**Figure 5-3**). Those who primarily use Zone 1 are less likely to perceive safety issues. When asked how serious of a safety problem is the number of boats on

the lake, users who recreate in Zones 2, 3, and 4 were more likely to indicate a problem from the number of boats.

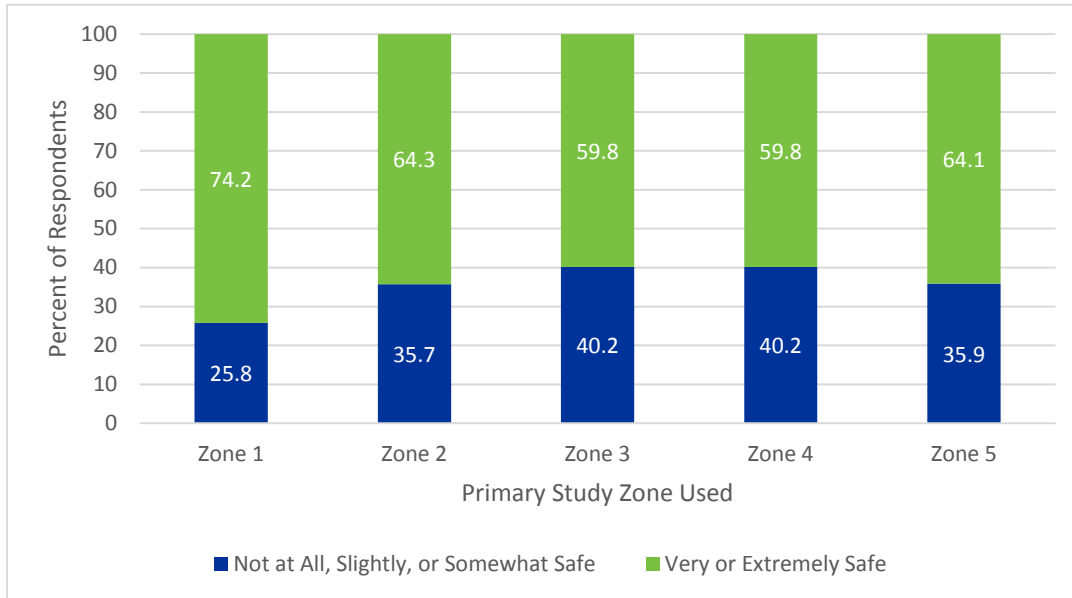


Figure 5-3. Boating Condition Safety by Primary Study Zone Used

5.2 Crowding

One out of four respondents indicated that they feel there is a problem from too many boats on Beaver Lake. Of those who indicated there is a problem, 54 percent said it is a moderate problem, and 14 percent noted it as a serious problem. Those who use rowboats, kayaks, or canoes were most likely to see a problem from too many boats (38 percent), followed by boaters using fishing or bass boats (30 percent). Those using speedboats, sailboats, ski boats, and pontoon boats all identified too many boats as a problem in about equal proportions (25, 23, 23, and 19 percent, respectively). Those using houseboats, cabin cruisers, and personal watercrafts were least likely to see a problem from too many boats (13, 14, and 16 percent, respectively).

Slight variations exist on user's perceptions of crowding based on the primary zone used for recreation activities. Respondents who use Zones 2 and 3 are more likely to indicate that a problem does exist from too many boats although the number remains close to that of Zones 1 and 4 (**Figure 5-4**). Residents are slightly more likely to indicate a problem from the number of boats on Beaver Lake when compared to non-residents.

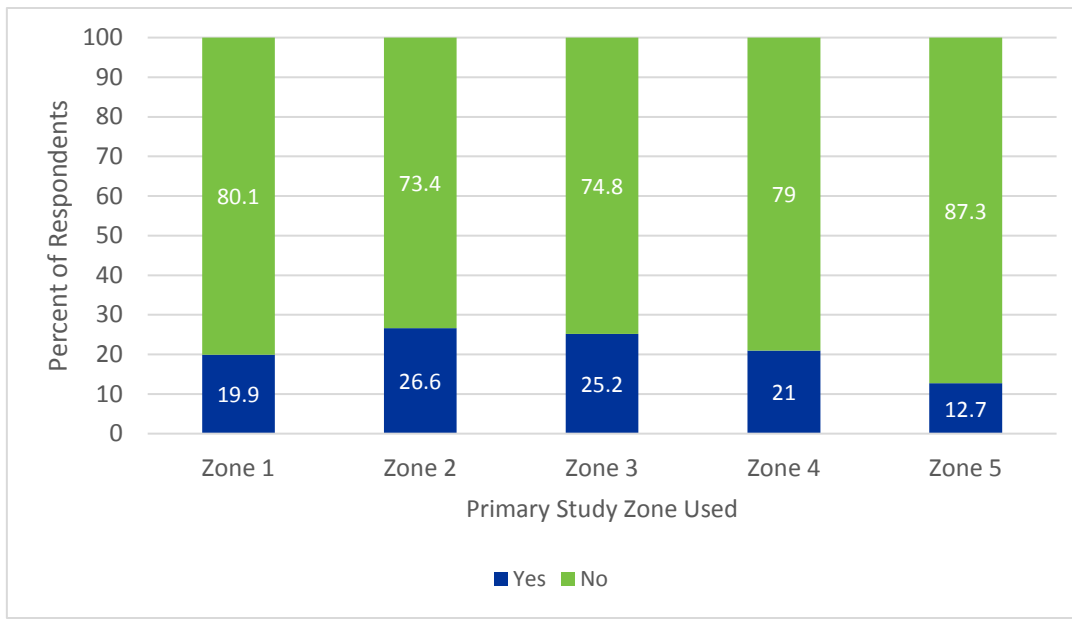


Figure 5-4. Respondents Indicating a Problem with too Many Boats by Primary Zone Used

Noise was said to reduce boating enjoyment for approximately half of all respondents, with 9 percent indicating that it has significantly reduced enjoyment. As with crowding, there are significant differences in perceptions of the amount that noise has decreased their enjoyment of the lake depending on the type of boat primarily used. Nearly 30 percent of rowboat/kayak/canoe users and 23 percent of sailboat users said that noise had decreased their enjoyment of the lake quite a bit or extremely. Residents of the lake (those living within 0.25 miles of the shoreline) tended to claim that noise from other boats was more likely to reduce their enjoyment of the lake. While 58 percent of non-residents said that their enjoyment of the lake was “*not at all*” reduced by noise from other boats, only 46 percent of residents said the same.

When asked to recall their last boating outing, respondents generally indicated that they saw as many boats as they expected to see (67 percent) and about as many boats as they wanted to see (73 percent). However, respondents who recalled a holiday weekend as their last outing (defined as Friday through Monday on Labor Day, Memorial Day, or Fourth of July) were much more likely to say that they saw more boats than they expected to see when compared to those who indicated their last outing as a day other than a holiday weekend day (25 percent compared to 8 percent). At about equal levels, those who reported their last outing was during a holiday weekend were also much more likely to say that they saw more boats than they wanted to see (28 percent compared to 8 percent).

In summary, the survey results indicate that crowding is not an issue for the majority of recreational boaters at Beaver Lake although some users reported that crowding has become a problem for them. Users who prefer non-motorized watercraft are more likely to see crowding and noise as an issue. While most boaters’ expectations for the number of boats on the lake were met and preferences were not exceeded, those visiting on holiday weekends were more likely to indicate that there was more crowding than they expected or preferred.

5.3 Response to Crowding

Most respondents (72 percent) did indicate that the presence of too many boats is likely to cause them to avoid their favorite places on Beaver Lake, as shown in **Figure 5-5**. One in four indicated that the presence of too many boats is quite or extremely likely to cause them to avoid a part of the lake. This indicates that boaters are responsive to the level of lake use and will experience negative consequences and change their behavior if the social carrying capacity at Beaver Lake is exceeded.

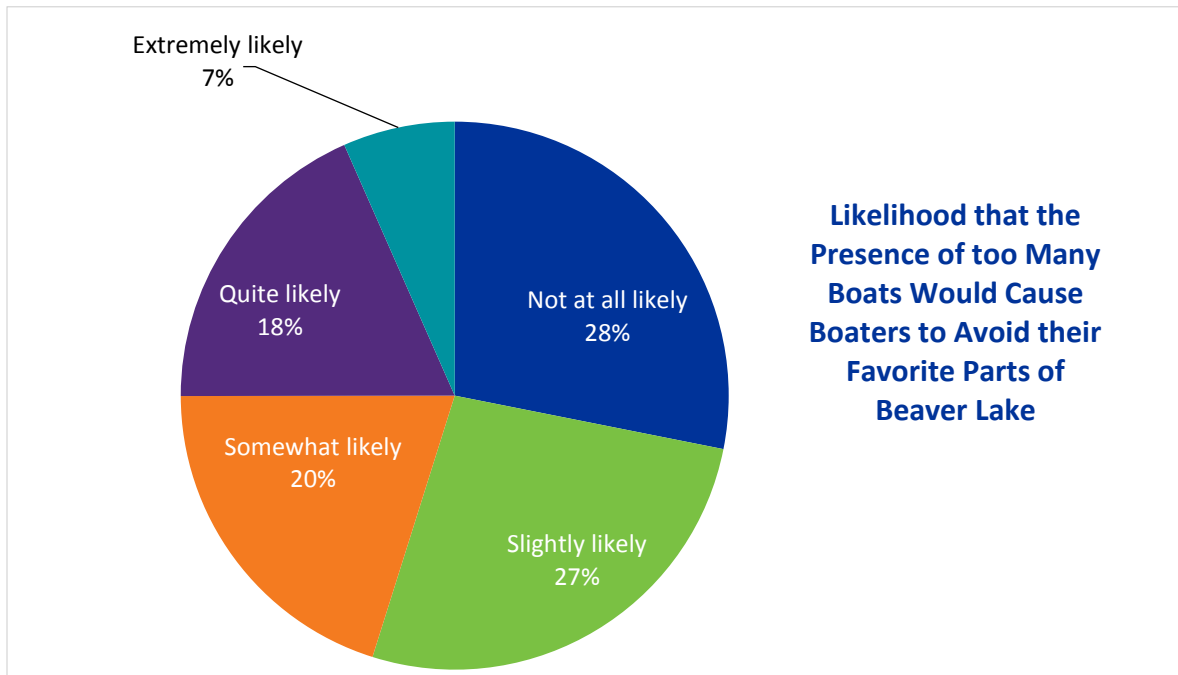


Figure 5-5. Boater Response to Crowding

5.4 Boater Survey Limitations

The survey was administered in October of 2016, following the summer boating period. Given the time lapse between the peak boating activities and the administration of the survey, it is possible that respondent perceptions of safety and crowding could have been dampened. That is, people may not have felt as strongly about concerns over safety and/or crowding after being so far removed in time from the boating experience.

Non-response was under 5 percent for any given question, with a few notable exceptions that should be considered. The question asking for the primary zone where boating activities occurred had a non-response rate of 5.2 percent. No difference was measurable between those completing the survey online or via paper mail back. The slightly higher non-response rate is likely due to respondents simply not knowing which zone they primarily recreate in or possibly that they perceived their use as equally distributed between two or more zones. The question asking for respondents to indicate the date of their last outing had a non-response rate of 8.9 percent. This is likely because the survey was administered in October and the respondents simply could not identify the date.

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Section 6

Carrying Capacity Benchmarks

In a carrying capacity study, an essential component is the calculation of an appropriate boating carrying capacity range that is specific to the lake under study. The appropriate boating carrying capacity is dependent on site-specific attributes, the lake setting, and users' preferences. Lake-specific factors to consider in calculating a range of boating capacities include water depth, shoreline configuration, lake setting and context, visitors' perceptions, number of accidents involving other boats, boat type and speed, and dominant boating activities.

The WALROS methodology developed by Reclamation has been utilized in several national carrying capacity studies as a means of developing an appropriate range of recreational boating capacities or densities. WALROS considers the physical, social, and managerial attributes of a lake and, based on user inputs, provides a range of densities appropriate for the lake. The WALROS calculation was used as the primary method for developing the carrying capacity benchmark ranges for Beaver Lake (Section 6.1). Additionally, a literature review was conducted to determine if the resulting WALROS range should be adjusted to account for the purely spatial constraints that exist at Beaver Lake (Section 6.2). Similarly, results of the boating survey were used to validate the resulting WALROS range (Section 6.3).

6.1 WALROS Calculation

WALROS is a methodology used to systematically classify recreational opportunities to determine appropriate management strategies. Application of the WALROS methodology allows users to classify a specific lake into a spectrum that ranges across urban, suburban, rural developed, rural natural, semi-primitive, and primitive recreation opportunities. The combination of lake-specific (or lake zone-specific) recreation activities, settings, experiences, and benefits define each of these classes. Physical, social, and management attributes are used to differentiate each of these six classes. **Table 6-1** provides an overview of the physical, social, and management attributes used to differentiate the six WALROS classes.

Table 6-1. Attributes Used to Differentiate WALROS Classes

| Physical Attributes | Social Attributes | Managerial Attributes |
|---|-------------------------------------|--|
| Degree of major development | Degree of visitor presence | Degree of management structures |
| Distance from major development | Degree of visitor concentration | Distance to developed recreation facilities and services |
| Degree of natural resource modification | Degree of recreation diversity | Distance to developed public access facilities |
| Sense of closeness to a community | Degree of solitude and remoteness | Frequency of seeing management personnel |
| Degree that natural ambiance dominates the area | Degree of non-recreational activity | |

WALROS classifications can be used to help managers make better and more defensible boating capacity decisions. To assist managers in this process, Reclamation developed a set of boating capacity coefficients based on collaborative expert opinion, professional experience, published articles and plans,

sound professional judgment, and the rule of reasonableness. The exercise of evaluating a lake or lake zones by the WALROS classifications helps managers understand the context in which users experience the lake. The classification system helps to explain differences in user perceptions between lakes and may indicate how lake zones on large lakes vary from each other.

In the WALROS inventory stage, a team of experts is asked to select and inventory a series of sites on the waterbody. For this study, the selected inventory sites are defined as the Beaver Lake study zones shown in **Figure 2-1** of Section 2. The team of experts used to inventory these sites consisted of the Beaver Lake Project Office operations management team and the Chief Rangers at Beaver Lake (herein referred to as “USACE experts”). For each inventory site, the USACE experts were asked to complete three inventory assessments of the lake.

- Physical Inventory – Physical attributes are features that are relatively permanent or fixed and not likely to change. The protocol worksheet for this inventory is provided in Appendix C.
- Social Inventory – Social attributes include the type of current recreation uses, nearby land and water activities, and special values and meanings associated with the area. The protocol worksheet for this inventory is provided in Appendix C.
- Management Inventory – Management attributes are those features that are provided for, managed, and may be changed by the managing agency or its partners. The protocol worksheet for this inventory is provided in Appendix C.

Using these worksheets, the USACE experts were asked to indicate the degree, extent, or magnitude that each attribute is present within each study zone.

To facilitate completion of the questionnaire, a desktop analysis of each study zone was completed to provide minimum, maximum, and average distances to facilities and services specifically mentioned within the questionnaire. This information was provided to and utilized by the USACE experts to answer questions specific to distance. Questionnaire results were compiled and analyzed.

The results of the WALROS questionnaire are illustrated in **Figure 6-1**, **Figure 6-2**, and **Figure 6-3**. As shown, there is some variation in the inventory for each study zone. Classifications generally range between “Urban” and “Rural Developed”, depending on specific questions and attribute class.

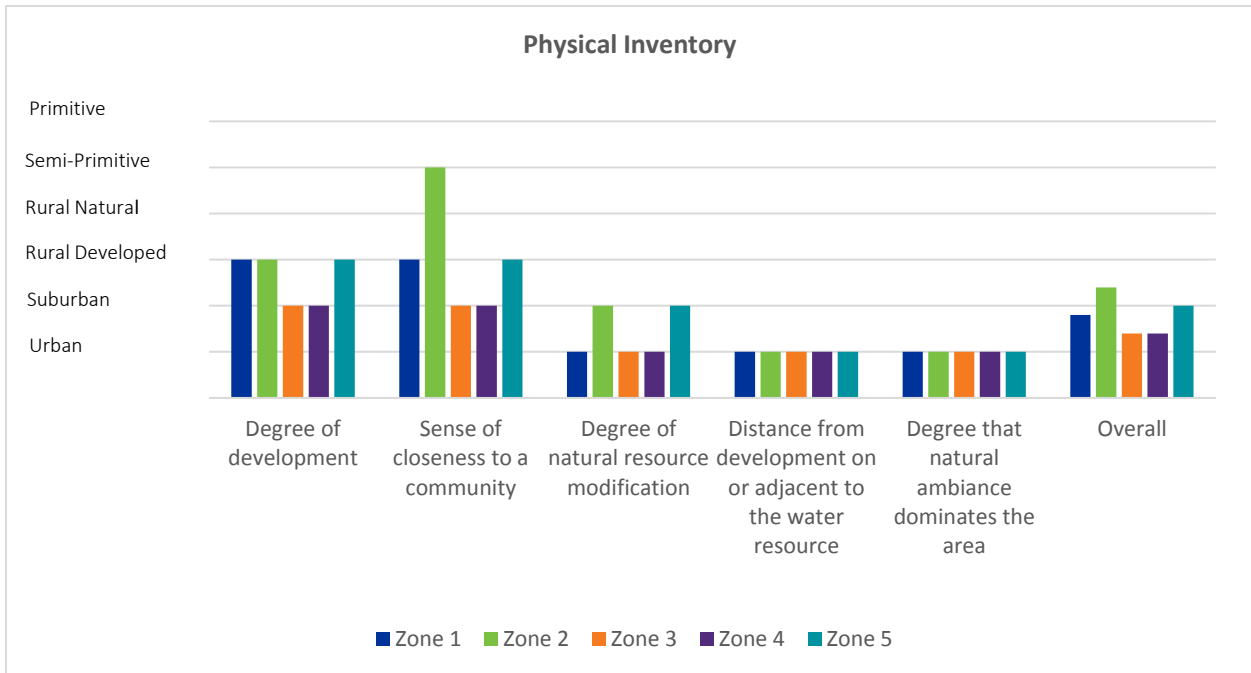


Figure 6-1. WALROS Physical Inventory Expert Results

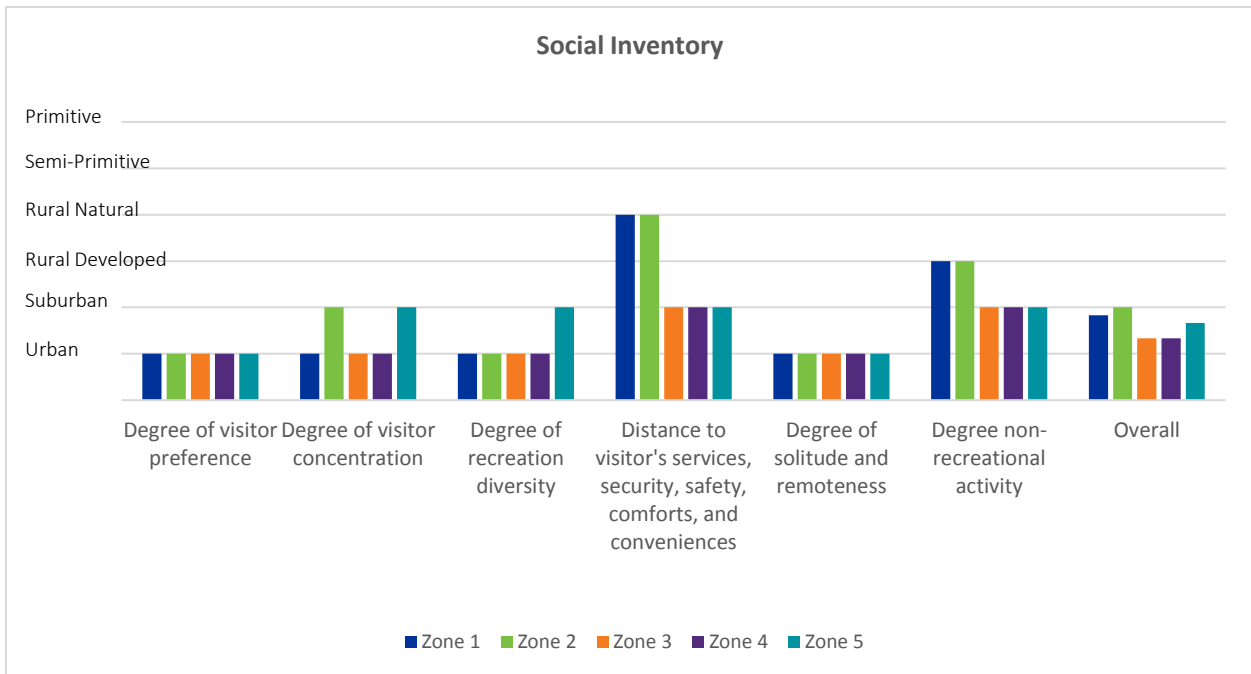


Figure 6-2. WALROS Social Inventory Expert Results

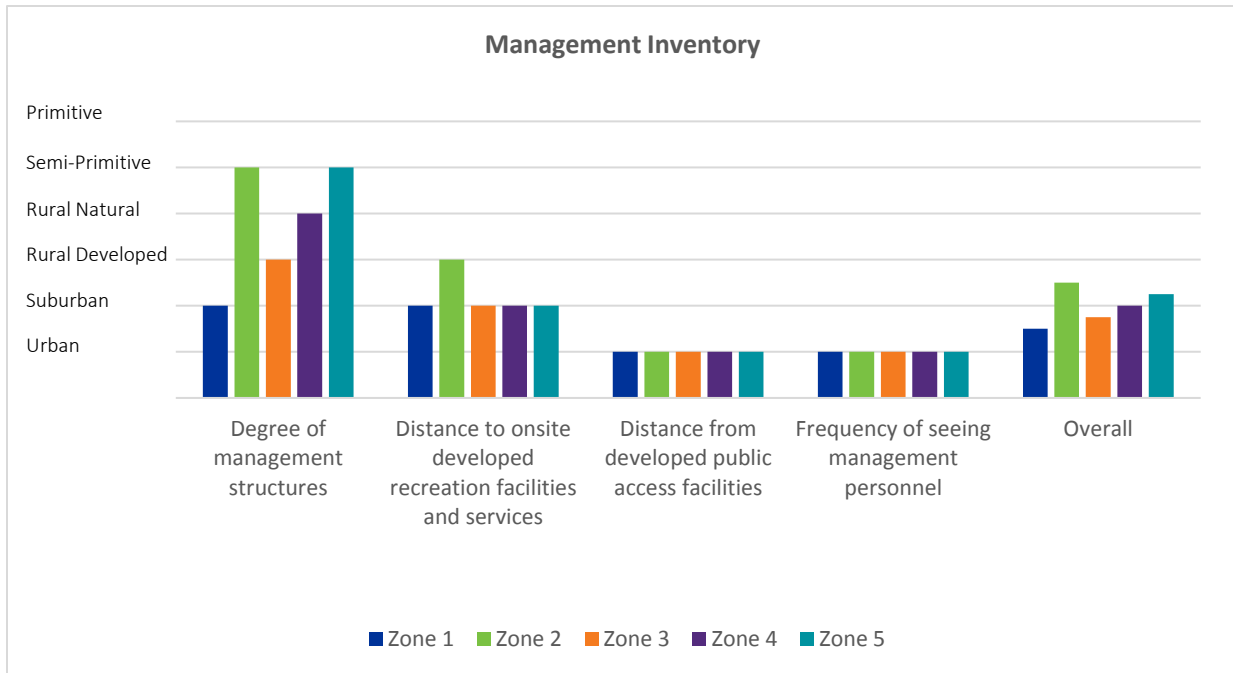


Figure 6-3. WALROS Management Inventory Expert Results

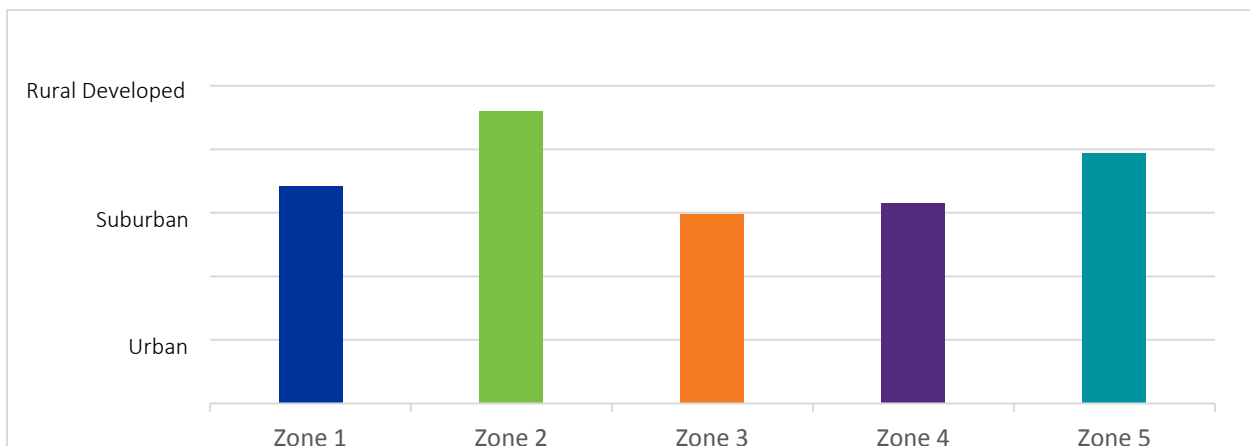


Figure 6-4. WALROS Inventory Classifications by Study Zone

Average values from the WALROS results provided by the team of USACE experts were used to indicate an appropriate WALROS classification for each study zone (**Figure 6-4**). The classifications for each study zone fall within the range of the “*Suburban*” classification. Zone 3 is classified as having the most development, visitor presence and concentration, and recreational diversity. This is most likely due to its location near the cities of Bentonville and Rogers as well as the larger marinas located within this zone. Zone 2 is classified as being closest to the “*Rural Developed*” classification, although still falling within the spectrum of the “*Suburban*” classification, due to an absence of management structures and greater distances to recreation facilities, visitors’ services, and community settings within this portion of the lake. Zones 1, 4, and 5 all fall between Zones 2 and 3 on the range of suburban classification. Overall, an

appropriate WALROS classification for all study zones at Beaver Lake is “*Suburban*”, which has an associated broad boating capacity range of 10 to 20 useable surface acres per boat.

To arrive at a more precise boating capacity by study zone, the WALROS Range Decision Tool was utilized (**Figure 6-5**). To assign the more precise recommended capacity ranges to each of the five study zones, information was utilized from the USACE experts, data outlined in Sections 2 and 3, data collected through the field survey, and results of the boater survey. Based on assessment of the data, Zones 1, 2, and 4 were determined to fall in the middle of the range, Zone 3 in the lower end of the range, and Zone 5 in the higher end of the range. Thus, the refined WALROS boat density ranges recommended for Beaver Lake are estimated at 14 to 17 acres per boat in Zones 1, 2, and 4; 18 to 20 acres per boat in Zone 3; and 10 to 13 acres per boat in Zone 5 (**Table 6-2**).

| <p>The purposes of this decision tool are to ensure that managers consider important factors affecting boating capacity and to help document the reasoned analysis in making a boating capacity decision. For each lake zone, consider the following factors that may affect boating capacity. Circle the description that best matches the situation. The preponderance of the answers will indicate which part of the capacity range may be more reasonable.</p> | | | |
|---|-----------------------------------|------------------|-------------------------------------|
| Typical size of boats | <15 feet | 16 to 25 feet | >25 feet |
| Typical speed of boats | <10 mph | 10 to 25 mph | >25 mph |
| Diversity of boating | | | |
| 1. different types of boats | low | moderate | high |
| 2. different size of boats | low | moderate | high |
| 3. different speed of boats | low | moderate | high |
| Boater visitation pattern | simple/predictable | moderate | complex/unpredictable |
| Level of boater stewardship/civility/respect for resource and other visitors | high | moderate | low |
| Shoreline configuration | simple/circular | moderate | complex/meandering |
| Boater destination or pass-through area | pass-through corridor/in-transit | mixed | destination area/overnight area |
| Extent of sensitive resources/potential for impact | low | medium | high |
| Compatibility with adjacent recreation/non-recreation land uses | high | moderate | low |
| Islands/shallows/hazards | infrequent | occasional | frequent |
| Historical public safety record/accidents/complaints/conflicts | infrequent | occasional | frequent |
| Level of boater management/rules/information/education/compliance | high | moderate | low |
| Suggested Capacity Range | Lower End (more boats) | Mid-range | Higher End (fewer boats) |

Figure 6-5. WALROS Boating Capacity Range Decision Tool

Table 6-2. WALROS Recommended Carrying Capacity Range for Beaver Lake by Study Zone

| Study Zone | Classification and Range Decision | Capacity Range (useable acres per boat) |
|-------------|-----------------------------------|---|
| Entire Lake | Suburban | 10–20 |
| Zone 1 | Suburban – Mid-range | 14–17 |
| Zone 2 | Suburban – Mid-range | 14–17 |
| Zone 3 | Suburban – Higher End | 18–20 |
| Zone 4 | Suburban – Mid-range | 14–17 |
| Zone 5 | Suburban – Lower End | 10–13 |

6.2 Spatial Carrying Capacity

Spatial capacity refers specifically and solely to the physical recreation activity constraints at the lake. Spatial capacity was estimated for Beaver Lake as a validation of the WALROS recommendation. An extensive literature review revealed many suggested spatial capacities or densities specific to individual lakes, boat types, and recreational boating activities. To determine an appropriate range of spatial carrying capacity specific to Beaver Lake based on the literature, the characteristics of Beaver Lake discussed in Sections 2 and 3 were reviewed and compared with existing studies. Additionally, boat type and speed as well as primary recreational activities during peak boating use periods were evaluated based on the field survey results discussed in Section 4 and the user perception survey discussed in Section 5.

Similar to the WALROS analysis, the majority of the literature reviewed encourages analysis of useable boating surface area, lake use characteristics, shoreline configuration, and a combination of boat type, size, speed, and activity when determining the spatial capacity. While Beaver Lake has a large useable surface area, as described in Section 2.3, the irregularity of the shoreline of Beaver Lake, especially in coves and the meandering portions of Zones 4 and 5 are important to take into consideration in determining a benchmark or appropriate spatial carrying capacity.

Additionally, boating incident data, as discussed in Section 3.2, are important in determining the overall safety record of the lake. While Beaver Lake ranks high in accidents compared to other recreational lakes in Arkansas, it was found that most of these accidents were not related to crowding. However, analysis of the data indicate that crowding-related incidents are much more likely to occur in Zones 2 and 3 than other areas of Beaver Lake (Section 3.2.2).

Dominant boat type used is also an important component in the determination of recommended spatial carrying capacities, as boat type is often indicative of boat speed and recreational activity. Based on both field survey results and user survey results, approximately 40 percent of recreational boaters utilize speed/ski/wake-style boats, 30 percent utilize pontoon-style boats, and 14 percent utilize fishing boats. Field survey results show that during peak boating periods, speed/ski and pontoon boats are far more

common than fishing boats. These types of boats are commonly used to pull skiers, wake boarders, and tubers, all of which require additional acreage to maintain safe conditions for all users. The field survey also indicates that these activities are distributed throughout the lake, except for Zone 5 where the lake narrows and is not ideal for these types of activities.

Based on these considerations and past studies, a conservative spatial boating carrying capacity for Beaver Lake would be 10 to 20 acres per boat. The range of carrying capacity is dependent on boat type and study zone. In the most crowded study zone, Zone 3, where high speed ski and speed boats dominate, the recommended density is the upper end of the range at approximately 20 acres per boat. Slower moving pontoon and fishing boats common in Zone 5 are assumed to be able to operate safely at a density of approximately 10 acres per boat based on study zone use patterns and historical incident data. This range of recommended spatial density or carrying capacity was derived specifically for Beaver Lake and may change as the boating use characteristics change over time.

The recommended ranges for study zones based solely on spatial requirements for a safe boating environment align with the WALROS estimation of carrying capacity by zone for Beaver Lake and do not warrant adjustments to the range provided in Table 6-2.

6.3 Social Carrying Capacity

An appropriate social carrying capacity is based on users' perceptions of crowding. The social carrying capacity is considered to be exceeded when conflicts arise, users no longer feel safe on the lake, or when the user chooses to no longer use the lake. As with the spatial capacity, social capacity was analyzed separately as a verification of the resulting WALROS range.

In developing the boater survey (Appendix B), question 18, which provided simulated photos of boating conditions on Beaver Lake, was intended to gauge users' optimal social carrying capacity. Given a series of five photos, the question asked which photo shows the maximum number of boats a respondent could see at one time on Beaver Lake without thinking it was too crowded. The photos provided within the survey are shown in **Figure 6-6**. The total acreage depicted within the photo is approximately 100 acres, which allows boat densities to be calculated for each photo.

A



B



C



D



E



Figure 6-6. Boater Survey Photo Simulations Used to Determine Social Carrying Capacity

The survey results are shown in **Figure 6-7**. Based on calculated boat densities associated with each simulation, 88 percent of boaters indicated a preference for boating densities that do not exceed 10 acres per boat. Furthermore, density that reaches 14 acres per boat exceeds the preference of 55 percent of boaters. These results indicate a socially acceptable boating carrying capacity range of between 10 and 20 acres per boat, according to the majority of the boater survey respondents.

There was a slight difference in the maximum number of boats that would be tolerated depending on which zone a respondent frequented. Most notably, Zone 3 users perceived Photo C as the maximum number of boaters before appearing crowded at greater levels than users of Zone 2 (36 and 27 percent,

respectively) (see **Figure 6-8**). There were no significant differences in responses to this photo array between residents of the lake and visitors to the lake nor by how the lake is accessed.

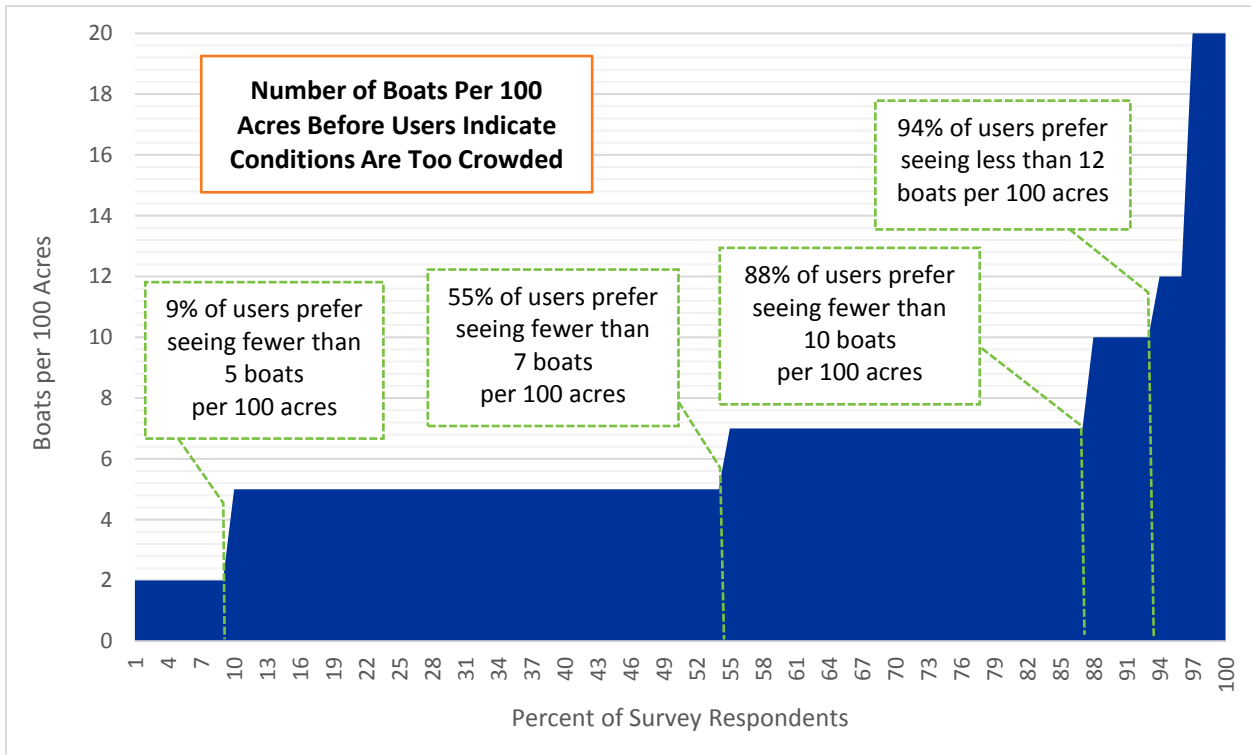


Figure 6-7. Boater Survey Respondent Optimal Social Boat Density

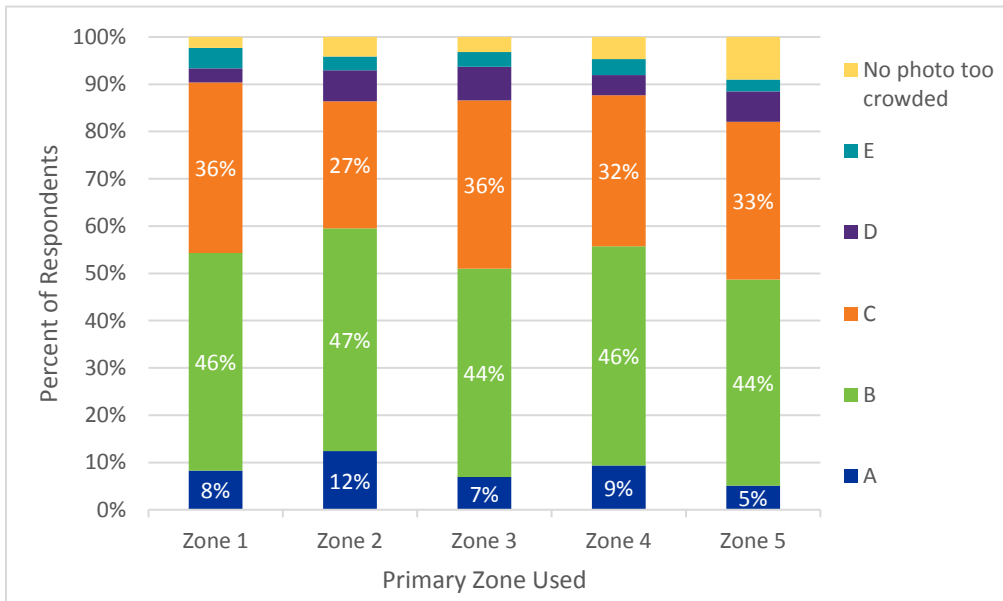


Figure 6-8. Boater Survey Respondent Optimal Social Boat Density by Study Zone

By primary zone used, there is not a significant amount of difference between the thresholds for preferred boating density before perceiving conditions as too crowded (**Figure 6-8**). Those who primarily recreate in Zone 2 have a slightly stronger preference to see fewer boats. For users of Zones 1, 3, 4, and 5, 77 to 82 percent of users selected either Photo B or Photo C while only about 74 percent of users in Zone 2 selected either of those photos.

Based on review of the optimal social boating density by study zone from the boater survey, the recommended range of boat density by zone derived from the WALROS method (**Table 6-2**) aligns with the social preferences for crowding specific to Beaver Lake boaters.

Section 7

Carrying Capacity Utilization and Facility Use

Boating activity was measured during four summer weekends in 2016, including two holiday weekends (Fourth of July and Labor Day) and two July weekends. In addition, survey was conducted to solicit boaters' perceptions of safety and crowding on Beaver Lake during the summer of 2016. From these data, existing boat densities and facility use rates were calculated. Using the Reclamation WALROS tool, recommended boating densities by study zone were calculated and verified through spatial and social density analysis. This section furthers the analysis of the information and data compiled to assess the recommended capacity that is currently utilized at Beaver Lake, overall and by study zone, and the impact that increases in facilities and private/public infrastructure may have on the boat density.

7.1 Boating Density Analysis

The estimate of maximum boats using the lake at one time is useful for calculating the existing boating density and other metrics of lake use. This measurement, herein referred to as "*BOATS*", is the total number of boats actively operating on the available water surface at any given point in time. This number is derived from the actual boat count from the aerial surveys. The greatest number of boats counted during any survey period was 1,450 for the overall lake. From this value, the current boat density can be calculated:

$$BOATS \text{ Beaver Lake} = 1,450$$

$$\text{Current Boat Density Beaver Lake Overall}$$

$$= \text{Total Useable Acres} \div BOATS$$

$$= 24,401 \div 1,450$$

$$= 17 \text{ useable acres per boat}$$

Given the recommended lake-wide range of 10 to 20 acres per boat developed using the WALROS analysis (see Section 6.1), during peak use times, Beaver Lake has currently reached the recommended boat density, as shown in **Figure 7-1**. This means that Beaver Lake, overall, currently has reached but not exceeded its carrying capacity.

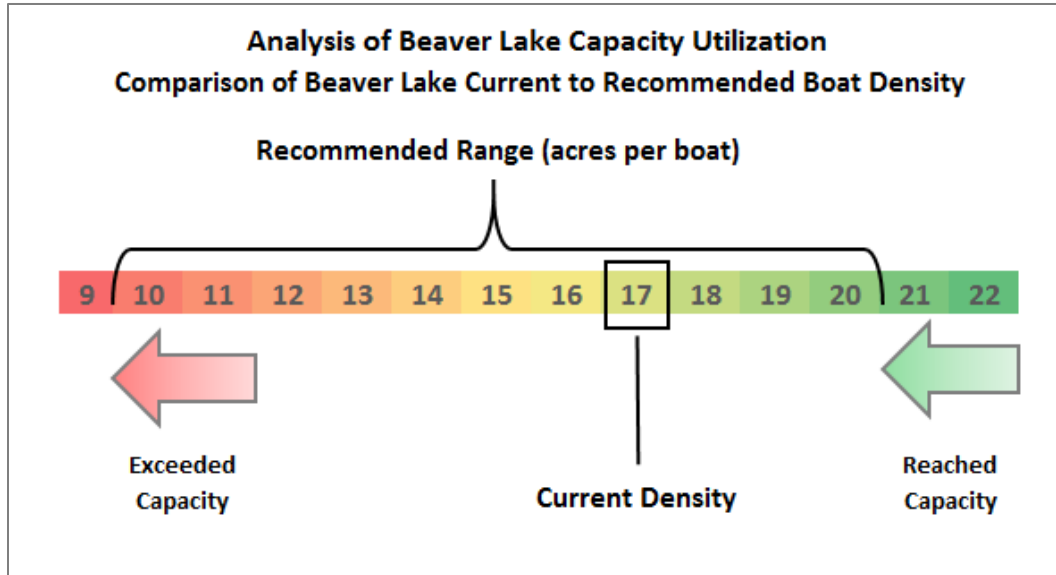


Figure 7-1. Beaver Lake Carrying Capacity Utilization

This calculation can be further evaluated by study zone to determine if the overall lake capacity metric varies by zone. **Table 7-1** shows the calculations of *BOATS*, *Current Boat Density* by study zone, and the recommended density. Comparing the *Current Boat Density* and recommended range of densities, the following conclusions are drawn:

- Zones 1, 3, and 4 have reached but not exceeded recommended carrying capacity.
- Zone 5 has not yet reached carrying capacity, as the data collected indicate that Zone 5 is underutilized and has a much lower boat density than it could accommodate given the typical boating activities that occur in Zone 5.
- Zone 2 has an observed *BOATS* of 455, resulting in a density of 12 useable acres per boat. Given the recommended density of between 14 and 17 acres per boat, Zone 2 has exceeded recommended carrying capacity.

Table 7-1. Observed to Recommended Boat Densities by Study Zone

| Study Zone | Useable Acres | Max Observed BOATS | Current Boat Density (useable acres/boat) | Recommended Range (useable acres/boat) | Analysis of Capacity Utilized |
|------------|---------------|--------------------|---|--|-------------------------------|
| Zone 1 | 5,104 | 297 | 17 | 14–17 | Reached |
| Zone 2 | 5,473 | 455 | 12 | 14–17 | Exceeded |
| Zone 3 | 7,493 | 394 | 19 | 18–20 | Reached |
| Zone 4 | 4,051 | 261 | 16 | 14–17 | Reached |
| Zone 5 | 2,280 | 68 | 34 | 10–13 | Not Reached |

The range of boat density can be used to estimate the *BOATS* that can safely use the reservoir without exceeding capacity. The calculation is:

$$\text{BOATS Capacity} = \text{Useable Acres} \div \text{Recommended Boat Density}$$

Table 7-2 presents this information by study zone and for the lake overall. Given the recommended range of boat density by zone, the recommended number of *BOATS* to remain within capacity is between 1,410 and 1,689. Given the peak *BOATS* observed for the lake overall, Beaver Lake's current utilization is between 86 and 103 percent of the recommended capacity. This utilization percent varies by study zone, with Zone 2 beyond the recommended utilization; Zones 2, 3, and 4 within or exceeding the lower-end of the range; and Zone 5 underutilized.

Table 7-2. Recommended BOATS by Study Zone and Overall

| Study Zone | Recommended Boat Density (Range) | Useable Acres | BOATS Capacity | | Current Percent Utilized of Recommend Capacity | |
|--------------|----------------------------------|---------------|----------------|--------------|--|------------|
| | | | Low-end | High-end | Low-end | High-end |
| Zone 1 | 14–17 | 5,104 | 300 | 365 | 99% | 81% |
| Zone 2 | 14–17 | 5,473 | 322 | 391 | 141% | 116% |
| Zone 3 | 18–20 | 7,493 | 375 | 416 | 105% | 95% |
| Zone 4 | 14–17 | 4,051 | 238 | 289 | 110% | 90% |
| Zone 5 | 10–13 | 2,280 | 175 | 228 | 39% | 30% |
| Total | 10–20 | 24,401 | 1,410 | 1,689 | 103% | 86% |

7.2 Total Boat Capacity and Boating Lake Use Rates

Boaters can access Beaver Lake from various infrastructure and facilities: public boat ramps, marina slips, or private, community, and resort docks. These can be referred to as access points or opportunities, wherein one access point is equal to an opportunity for one boat to engage in boating activities on Beaver Lake. The *Total Access Opportunities*, then, is the total number of boats that can be moored or stored at an approved moorage facility, such as a marina or boat dock, plus the total number of boats that can be placed on the water surface using an approved boat ramp or launch facility. The number of boats that can be placed on the water surface from public boat ramps is calculated as the number of boat trailer parking spaces available. Currently, the *Total Access Opportunities* for Beaver Lake is 7,843 boats and was calculated as follows:

$$\begin{aligned}
 &711 \quad \text{Boat trailer parking spaces at boat ramps (Table 4-9)} \\
 + &1,957 \quad \text{Marina wet slips (Table 2-3)} \\
 + &5,175 \quad \text{Slips at private, community, and resort boat docks (Table 2-2)} \\
 = &7,843 \quad \text{Total Access Opportunities}
 \end{aligned}$$

Facility Use Rate is a measure of the estimated number of boats on the lake at any given time from the access points. *Facility Use Rate* is calculated by dividing the *Total Access Opportunities* by *BOATS*. Currently the *Facility Use Rate* for Beaver Lake is 19 percent and is calculated as follows:

$$\begin{aligned} \text{Facility Use Rate} &= [\text{Total Access Opportunities} \div \text{BOATS}] * 100 \\ &= [1,450 \div 7,843] * 100 = 19 \text{ percent} \end{aligned}$$

Therefore, during peak use periods, one can reasonably expect that 19 percent of all available access opportunities will result in a boat on the water. *Facility Impact Rate* furthers this calculation to express the impact that adding “X” number of access opportunities has on *BOATS*:

$$\text{Facility Impact Rate} = 100 \div \text{Facility Use Rate} = 5:1$$

The *Facility Impact Rate* can be interpreted as follows: *At Beaver Lake, adding 5 access opportunities results in 1 additional boat on the water during peak times.* The *Facility Impact Rate* is a measure of the proportion of available access infrastructure to *BOATS*. It can be a useful tool to estimate the effects of changes in *Total Access Opportunities* on *BOATS*. That is, if the available infrastructure for accessing the lake were to change, the lake use rate provides a way to estimate how those changes would affect the number of boats on the lake at one time and thus the boating density should the observed use rate remain constant in the future.

It is possible to break the *Facility Use Rate* and *Facility Impact Rate* down by facility type, as shown below. The boat ramp facilities have the highest impact on *BOATS*, with an impact ratio of 1:1, followed by marinas with a ratio of 4:1. Private, community, and resort dock slips have the lowest impact on *BOATS* with an impact ratio of 14:1. Note: Slips associated with sailing clubs are included with the private, community, and resort dock slips.

- **Marinas**

- *Marina Facility Use Rate* = $[556 \div 1,957] * 100 = 28$ percent
- *Marina Facility Impact Rate* = $100 \div 28 = 4:1$

- **Boat Ramps in Public Recreation Areas**

- *Boat Ramp Facility Use Rate* = $[638 \div 711] * 100 = 90$ percent
- *Boat Ramp Facility Impact Rate* = $100 \div 90 = 1:1$

- **Private, Community, and Resort Dock Slips**

- *Private, Community, and Resort Dock Slips Facility Use Rate* = $[368 \div 5,175] * 100 = 7$ percent
- *Private, Community, and Resort Dock Slips Facility Impact Rate* = $100 \div 7 = 14:1$

7.3 Analysis Discussion

The recommended boat density from WALROS and other studies is similar to the densities the majority of survey respondents selected as the point beyond which the lake would be too considered crowded. Because Beaver Lake is currently within the recommended boating density, and only exceeds it in limited areas or for limited periods of time, it is not surprising that more survey respondents did not rank current crowding as a significant issue. However, there is evidence that boaters are beginning to experience negative consequences. One in 3 survey respondents did note at least some level of concern regarding boating safety, and 58 percent indicated that they feel that the number of boats on Beaver Lake is creating a safety problem. Comments received during the 2015 and 2016 MP and SMP scoping processes for Beaver Lake indicated a desire for greater boater safety through the regulation of boat size/type and speed, increased enforcement of rules, or increased patrols. Zone 2 exceeded recommended capacity during the study period and has seen 5 times more crowding-related incidents over the past 6 years than Zones 1 or 4. Zone 2 is also known to lake management as having several “party cove” areas in which several boats will tie together in a cove. These areas were verified during helicopter flyovers and contribute to the high *BOATS* estimates observed within this zone. While a gathering of stationary boats in coves generally does not contribute to a lake-wide crowding issue or an increase in the frequency of accidents, it can contribute to crowding and accidents as boats return to their point of origin.

Given that the NWARPC projects the population of Springdale, Bentonville, Bella Vista, Lowell, and Centerton will more than double from 2015 to 2035, the demand for recreational boating opportunities at Beaver Lake is likely to increase. The public boat ramp facilities are currently experiencing a 1:1 *Facility Impact Rate*. However, only 7 percent of the existing private, community, and resort boat dock slip owners are currently boating at one time. Given the large number of these boat slips on Beaver Lake, even minor changes to this use pattern can impact the number of boats on the water at any given point in time. From this information, lake managers can better plan for the future of Beaver Lake and strive for a healthy, balanced level of recreational boating.

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Section 8

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