APPENDIX G

Raystown Lake Boating Carrying Capacity Study

Raystown Lake Boating Carrying Capacity Study

Final Report

Prepared for:
U.S. Army Corps of Engineers
Baltimore District
2 Hopkins Plaza
Baltimore, MD 21201

Prepared by:
CDM Federal Programs Corp.
1050 North Reed Station Road, Suite D
Carbondale, IL 62902

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CDM Smith

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Acronyms

BUI	boating under the influence
CDM Smith	CDM Federal Programs Corporation
GIS	geographic information system
mph	mile(s) per hour
PFBC	Pennsylvania Fish and Boat Commission
PWC	personal watercraft
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
USACE	U.S. Army Corps of Engineers
VERS	Visitor Estimation Reporting System
WALROS	Water and Land Recreation Opportunity Spectrum

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Executive Summary

In the summer of 2018, a recreational boating carrying capacity study was completed on Raystown Lake, Pennsylvania (Figure ES-1), for the Baltimore District of the U.S. Army Corps of Engineers (USACE). This study characterizes current peak boating use and boaters' perceptions and preferences 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 Raystown Lake setting. Additional information regarding facility carrying capacity was collected and is presented to assist in future lake management decisions. An overview of the study process is shown in Figure ES-2. All results indicate that carrying capacity at Raystown Lake has been reached or exceeded. The observed peak boating density at Raystown Lake is currently 5.7 acres per boat which is well beyond recommended standards for boating density and the crowding thresholds of lake users.

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

Over three high-use summer weekends, field data were collected on recreational boating use. 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. Empty marina slip counts were tabulated utilizing aerial photography. Field data were utilized to determine the number and types of boats using the lake at any given time and, ultimately, the observed boat density. The collected information provides insights into boat origin and existing utilization levels of lake access facilities and infrastructure during peak times.

A user survey targeting boaters at Raystown Lake was administered following the summer boating period in the fall of 2018. The survey provides information on user characteristics, on-water activities, and perceptions of safety, crowding, displacement, and preferred boat density. This information was used to define an acceptable range of social boating carrying capacity at Raystown Lake and to assess the impact of existing boating density on the quality of the recreational experience and boating safety. The survey, approved by the U.S. Office of Management and Budget, follows the requirements and guidelines for federally sponsored data collections. The survey was offered both online and via mail-out/mail-back format. The total boating population that currently recreates on Raystown Lake is estimated at 22,740 boaters per month during the peak season. Administration of the survey was targeted at these boaters identified through marina slip rentals, master planning databases, and campsite users. The survey was administered to 3,558 boaters with 1,367 completed surveys received, representing a 38 percent response rate that provides a statistically valid sample.

To provide the context and setting for interpretation of the results, the lake and surrounding area were characterized with input from the USACE Raystown Lake Project Office management staff and rangers. A literature review was completed to identify nationwide studies of similar nature with established carrying capacity densities and benchmarks. Additional data collected and analyzed for the study included the 1988 Boating Capacity Study at Raystown Lake, boating incident and fatality data

for Raystown Lake, visitation data, an assessment of existing infrastructure, parking citations, boat launch capacity days, and a lake characterization following the Water and Land Recreation Opportunity Spectrum (WALROS) developed by the U.S. Bureau of Reclamation.

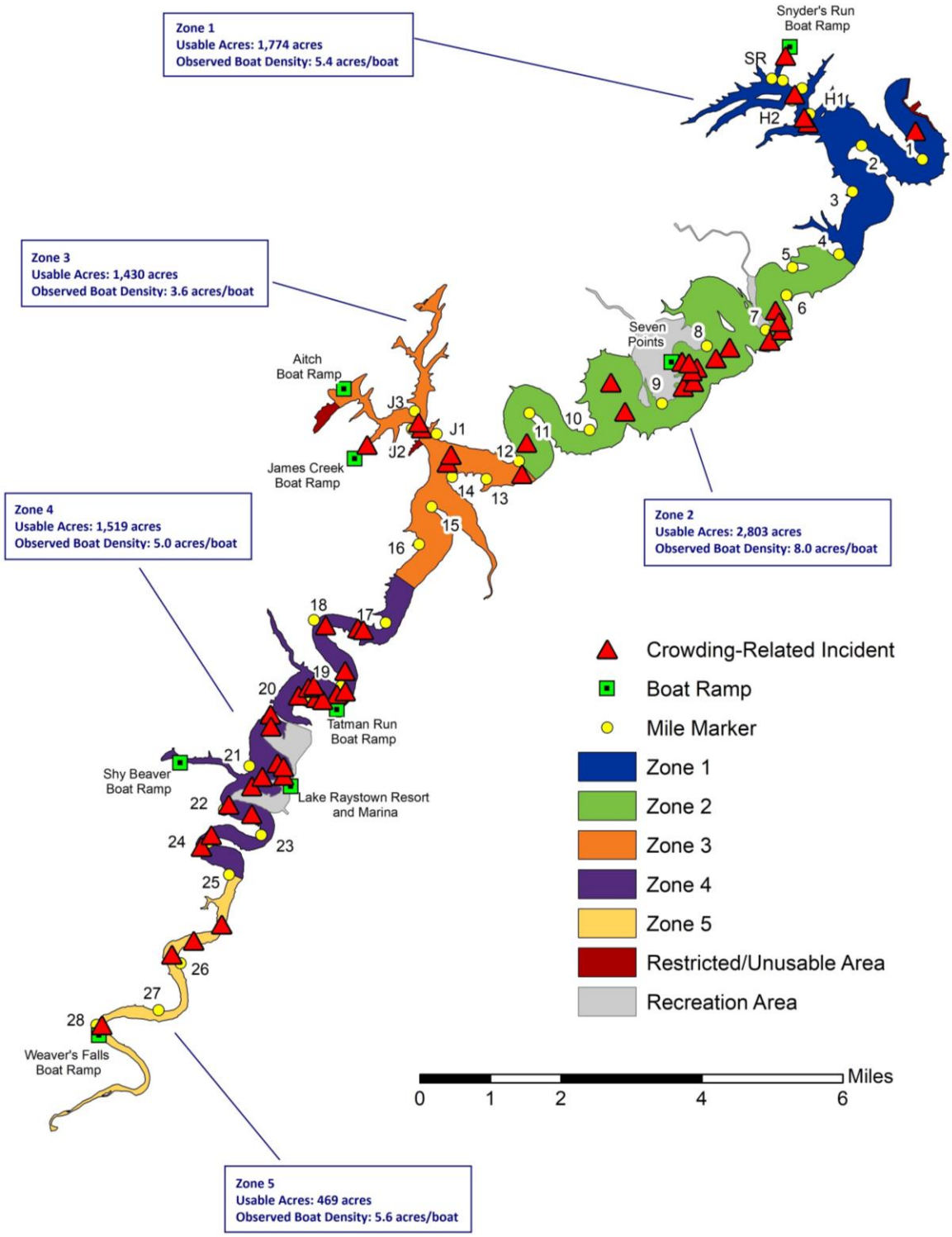

Figure ES-1. Raystown Lake Study Zones, Observed Peak Boating Density and Key Data

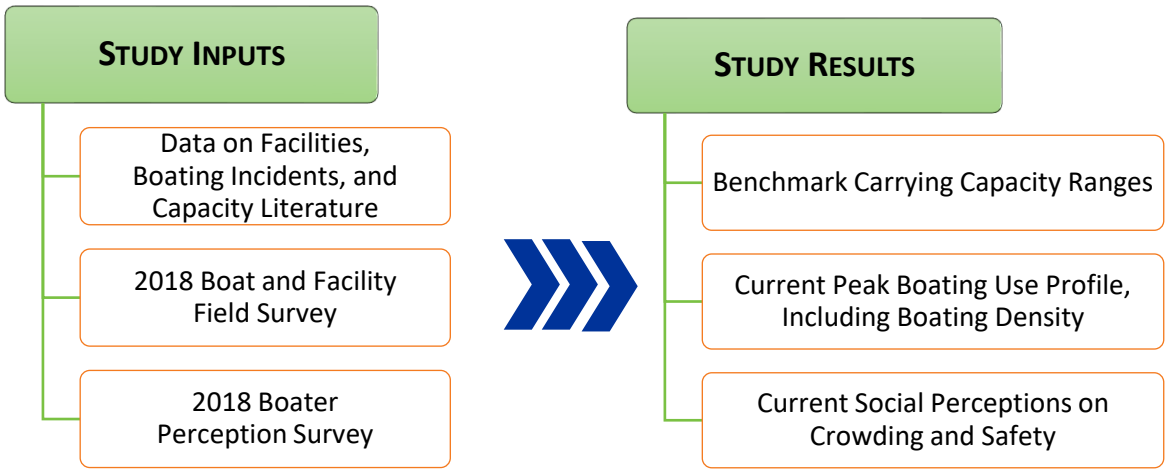

Figure ES-2. Raystown Lake Recreational Carrying Capacity Process Overview

ES.1 Current Peak Boat Use and Origin

Of the three field collection dates, a peak number of 1,414 boats were tallied during the weekend prior to the Fourth of July holiday. The observed peak boating density for Raystown Lake is calculated by dividing the usable water surface acres by the boat count from the survey period that tallied the greatest number of boats:

Observed Peak Density = 7,995 acres ÷ 1,414 boats = 5.7 acres/boat

The analysis of boat density was completed for each of five study zones as well. Density by zone varied over each of the three high-use weekends. **Table ES-1** and **Figure ES-2** provides the observed maximum boat density for each study zone. Zone 3 was found to have the greatest density of boats at 3.6 acres per boat followed by Zone 4 at 5.0 acres per boat.

Table ES-1. Observed Boat Density by Study Zone

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Usable Acres	1,773	2,803	1,430	1,519	469
Maximum Number Observed Boats	330	352	397	302	84
Usable Acres per Boat	5.4	8.0	3.6	5.0	5.6
Observation Date	6/30/18	8/4/18	6/30/18	7/7/18	7/7/18

Boaters can access Raystown Lake from various infrastructure and facilities: public boat launch ramps, marina slips or ramps, or resort docks. The number of opportunities available at these facilities has a direct impact on the total number of boats that can access the water during peak boating. Access opportunities and facility impact rates were calculated for Raystown Lake using data collected during the field survey. The *Total Access Opportunities* is the total number of boats that can be moored or stored at an approved moorage facility, such as a marina, plus the total number of boats that can be placed on the water surface using a USACE-managed boat ramp or launch facility. The *Total Access Opportunities* for Raystown Lake is 2,297 boats and was calculated as follows:

701	Boat trailer parking spaces at USACE-managed boat ramps (**Table 2-4**)
+ 1,596	Marina slips (**Table 2-3**)
= 2,297	Total Access Opportunities

Facility Use Rate is a measure of the estimated number of boats on the lake at peak times from the access points. *Facility Impact Rate* furthers this calculation to express the impact that adding "*X*" number of access opportunities has on the number of boats on the water. The *Facility Impact Rate* is a measure of the proportion of available access infrastructure to boats on the water at one time. It can be a useful tool to estimate the effects of changes in *Total Access Opportunities* on boats on the water at one time. That is, if the available infrastructure for accessing the lake were to change, the *Facility Impact 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. The *Facility Use Rate* and *Facility Impact Rate* were calculated for marinas and boat ramps in public recreation areas, as shown below. The USACE-managed boat ramp facilities have the highest impact on boats on the water at one time, with an impact ratio of 1:1, followed by marinas with a ratio of 3:1.

- **Marinas**
  - *Marina Facility Use Rate* = [584 ÷ 1,596] * 100 = 37 percent
  - *Marina Facility Impact Rate* = 100 ÷ 37 = 3:1
- **USACE-Managed Boat Ramps in Public Recreation Areas**
  - *USACE-Managed Boat Ramp Facility Use Rate* = [601 ÷ 701] * 100 = 86 percent
  - *USACE-Managed Boat Ramp Facility Impact Rate* = 100 ÷ 86 = 1:1

Field data were 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 and marinas. This calculation includes empty boat trailers that were parked at facilities such as campgrounds, resorts, and marinas. The field data indicate that during peak boating periods, approximately 65 percent of the boats on the water originate from boat ramps, with the additional 35 percent originating from marinas. Parking spaces at USACE-managed boat ramps are essentially fully utilized during peak boating, and marina slip occupancy is 100 percent.

Per the field collection data, the most popular type of boat during peak use was speedboats (44 percent); followed by pontoons (26 percent), personal watercrafts (PWCs) (13 percent); nonpowered kayaks, canoes, or paddleboats (6 percent); boats pulling water-skiers or tubers (4 percent); houseboats (4 percent); and fishing boats (3 percent). The greatest number of pontoon boats were found in Zone 2. Houseboats were found most often in Zone 3. Skiers utilized Zone 2 most often. Speedboats utilized Zones 1 and 2 while Zone 4 was most popular for PWC users.

ES.2 User Perceptions on Safety and Crowding

An appropriate social carrying capacity is based on users' perceptions of boating safety and 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. Sixty-seven percent of surveyed boaters at Raystown Lake agreed to strongly agreed with the survey statement *boating conditions on the lake are generally safe*. Twenty-six percent of boaters indicated that there is generally an unsafe number of boats on the water. Statistically, boaters living near the lake are much more likely to indicate there is an unsafe number of boats on the water. More than one-quarter of boaters indicated there are locations on Raystown Lake that are unsafe. Those who felt unsafe were further asked their reasons for feeling unsafe. The top reasons for concern were crowding or heavy boat traffic (32 percent) and speed or driving behavior of other boats (30 percent).

Boaters also reported higher levels of feeling crowded when responding to questions regarding crowding at Raystown Lake. In total, more than half of boaters indicated that there is a moderate to big problem from too many boats on Raystown Lake. Respondents' feelings on crowding at boat ramps, on the water, and at the marina varied. For areas around boat ramps, 50 percent of respondents indicated feeling extremely to moderately crowded. On the water, 68 percent of respondents reported feeling moderately to somewhat crowded.

ES.3 Carrying Capacity Benchmarks for Raystown

Carrying capacity can be assessed in a number of ways and takes into account the social preferences and physical capacity of the reservoir. WALROS is a methodology used to systematically classify recreational opportunities that captures both to determine appropriate management strategies and the appropriate boating density. Application of the WALROS methodology allows managers 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. WALROS was executed by CDM Smith using a desktop analysis and inputs from USACE Project Office staff. Results for Raystown Lake indicate some variation in the inventory for each study zone, with classifications generally falling between *Suburban* and *Rural Developed*, depending on specific questions and attribute class. The *Rural Developed* zone classifications are primarily due to the narrow setting of some zones and absence of development around the visible shoreline. Many users of the lake, however, are traveling from urban and suburban areas from across the state and are likely to tolerate more dense boating experiences. Thus, a single classification of *Suburban* was determined for Raystown Lake. These results translate to an associated broad boating capacity range of 10 to 20 usable surface acres per boat. The lower end of the recommended range is 10 usable acres per boat and should be considered the minimum optimal density for Raystown Lake.

The WALROS calculation aligns with user preferences for density as collected through the boater survey. Based on calculated boat densities associated with a question containing boat density photo simulations, nearly 9 out of 10 boaters indicated that a boating density beyond 10 acres per boat is too crowded. Furthermore, 7 out of 10 boaters indicated that a boating density beyond 12.5 acres per boat is too crowded. **Figure ES-3** highlights the social carrying capacity and crowding thresholds at

various density levels at Raystown Lake. See Section 4.3.4 for additional information on this survey question and interpretation of results.

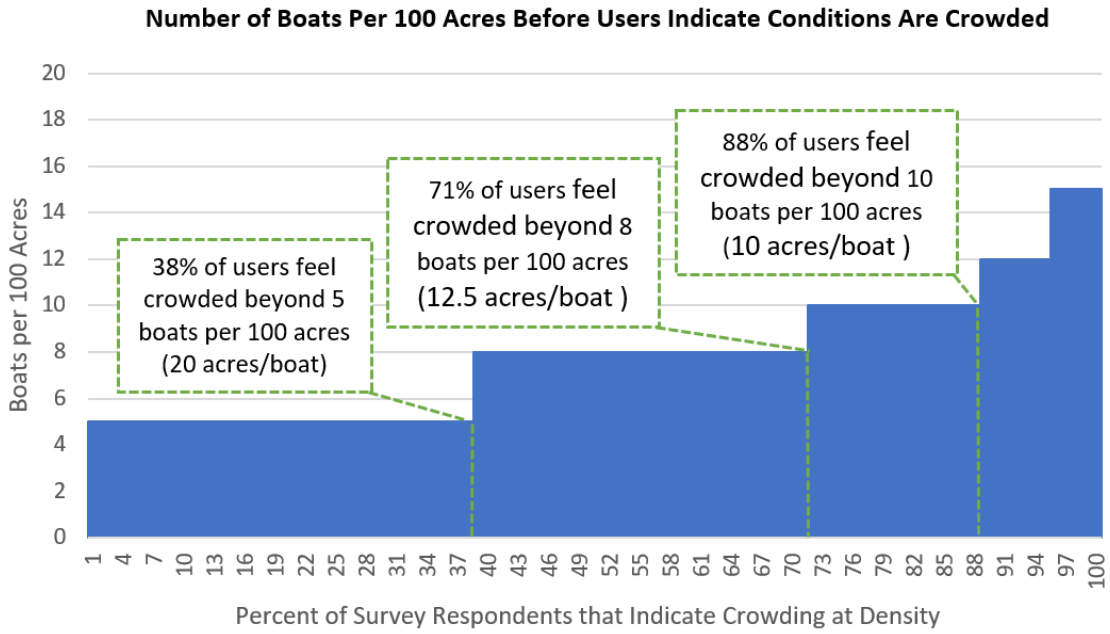

Figure ES-3. Social Carrying Capacity and Crowding Threshold at Raystown Lake

Another indicator that social carrying capacity has been reached or exceeded is reported displacement actions taken by boaters. Questions were asked to attempt to measure the extent to which crowding displaces boaters from Raystown Lake. More than half of the boaters surveyed at Raystown lake indicated that they generally stay off the lake during part of the day or week because of too many boats on the water. Boaters living near the lake as well as those fishing are much more likely to avoid the lake during parts of the day or week due to crowding. Nearly half of boaters indicated that there are some boating activities they do not participate in due to crowded conditions. Forty-three percent of respondents indicated that there are locations on the lake that they deliberately avoid due to crowding.

Literature and available studies were collected and reviewed so that Raystown Lake can be compared to other lakes around the nation. The overall recommended density from 18 boating capacity studies that were collected averaged 12.5 acres per boat, with a range of 3.5 to 22. Those lakes in the lower density range are mostly small reservoirs with a high level of development around the lake. Examples of published optimum boating densities from numerous boating capacity methodology literature had a vast range of recommended boat densities, but the combined average was 16.8 acres per boat.

ES.4 Changes in Boating Since 1988

Over the summer of 1987, a study was conducted on Raystown Lake to understand peak boat use patterns and their effect on boating quality on the lake (Graefe et al. 1988). It is useful to compare boating conditions, facility counts and use, and boater perceptions as recorded in that study to the current conditions characterized in this study to assess any major changes in conditions over the past

30 years. **Table ES-2** presents a summary of key data from the 1988 and current study. As shown, more than 300 additional boats were found to be using the reservoir during peak summer use, an increase of 28 percent. At the same time, the number of access opportunities (marina slips and car/trailer spaces) increased by the same percentage for a total of 500 additional measurable access opportunities added.

Table ES-2. Comparison of Current Study with 1988 Boating Study

Description	1988 Study	2018 Study
Usable Lake Surface	8,500 Acres	7,994 Acres
Total Marina Slips	1,200	1,596
Total Car/Trailer Spaces	579	701
Greatest Number of Boats Recorded	1,101	1,414
Boating Density Range (Acres per Boat)	10.5 to 7.5 (Avg. 9)	8 to 3.6 (Avg. 5.7)

In terms of the type of boats utilized on Raystown Lake, there were changes from 1988 to 2018. In the 1988 study, pontoon boats made up only 6 percent of total boaters surveyed. This increased to 33 percent of current users. The size of boats has increased over time as well, with 69 percent of boats measuring greater than 20 feet in 1988 compared to 93 percent in 2018.

Over half of surveyed current users reported feeling moderately to extremely crowded on the water, compared to 36 percent of survey respondents in the 1988 study. Perceptions on displacement have significantly increased as well, as shown in **Table ES-3**. On the questions that can be directly comparable, boaters report more displacement and perceptions of feeling less safe on all accounts.

Table ES-3. Comparison of User Perceptions in Current Study with 1988 Boating Study

	% Respondents Agree	
	1988 Study	2018 Study
I generally stay off the lake during parts of the day/week because of too many boats on the lake	27%	55%
I generally do not participate in some boating activities because of crowded conditions at the lake	23%	45%
There are generally an unsafe number of boats on the water	17%	26%
Other boats generally come closer to my boat than I like	34%	41%
The behavior of other boaters generally interfered with the quality of my boating experience	22%	33%
Boating conditions on the lake are generally safe	78%	67%

ES.5 Study Conclusions

This study collected comprehensive data regarding boat use levels, facility impacts, crowding, and safety. All study results indicate that carrying capacity at Raystown Lake has been reached or exceeded. Numerous boating capacity studies across the nation recommend densities around 12.5 acres per boat, and the WALROS calculation for Raystown recommends a maximum density of 10 acres per boat. The observed density at Raystown Lake peaked at 5.7 acres per boat (single day,

lakewide), with Zone 3 having an even higher density of 3.6 acres per boat, well beyond recommended standards.

Over the past 30 years, the boating density at Raystown Lake has increased nearly proportional to the additional number of access opportunities added over that period. Over 500 access opportunities have been added and the peak boating increased by 300 additional boats on the water. It is reasonable to assume that future increases in access opportunities will proportionally increase the number of boats utilizing the reservoir during peak boating days and further increase boating density.

Data and survey results also indicate that the social carrying capacity has been reached or exceeded. More than two-thirds of boaters feel somewhat to moderately crowded on the water, and more than half indicated there is a moderate to big problem with too many boats on the water, exceeding the thresholds for social capacity established in literature (ERM, Inc. 2004). Eighty-eight percent of boaters indicate they feel crowded at boating densities that exceed 10 acres per boat. This is far less dense than the current peak boating on the lake.

Boaters have responded to crowded conditions by avoiding activities, places, and days and times of the week, generally reporting a high level of displacement. Forty-five percent of boaters indicate they avoid certain activities due to crowding. On the questions that can be directly comparable to the 1988 study of Raystown Lake, boaters report more displacement and perceptions of feeling less safe on all accounts. It is reasonable to associate these changes in user experiences to the increase in boat density over the past 30 years. If boat density further increases, it is highly likely that positive boating experiences will decline.

Raystown Lake has, on average, seven boating incidents per year, with two to three caused by crowding. These crowding-related incidents at Raystown Lake resulted in bodily injury 68 percent of the time. A recent study of Beaver Lake in northwestern Arkansas reported a similar per year crowding-related incident rate; however, Beaver Lake has more than three times the usable boating acreage when compared to Raystown Lake (CDM Smith 2017). Beaver Lake was found to have the highest incident rate in its region. Lake George, located north of Albany, experiences what is reported as a high incident rate, with an average of 17 incidents per year (Lake George Park Commission 2016). Lake George is also three times the size of Raystown Lake but has fewer boating incidents per usable acreage. While direct comparisons on incident data are limited, it appears that Raystown Lake has a high rate of boating incidents.

Should peak boating numbers persist, management activities could be implemented to mitigate areas of high congestion, with the goal of reducing boater conflicts. Studies indicate that waterskiing requires 12 to 20 acres per boat for safe conditions (Jaakson et al. 1989; Warren and Rea 1989). While few waterskiing boaters were observed during peak boating (making up only 4 percent of the total boaters), it is reasonable to assume that if boating densities continue to peak at 2018 levels, this type of activity should be prevented during peak weekend and holiday boating days to ensure the safety of the boaters. Without management actions to reduce the number of boats on the water, management actions could be undertaken to ensure safety such as speed limit enforcement in areas with high congestion and clusters of boating incidents. Additionally, many of the crowding-related boating

incidents occurred from large wakes created by other boats. Speed limits and boat size constraints could mitigate the occurrence of these incidents.

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Section 1
Introduction

Located in Huntingdon County, Pennsylvania, Raystown Lake is the largest lake within the state, making it a popular attraction for nature lovers and water enthusiasts during all seasons. The Raystown Lake dam is vital to the protection of downstream communities along the Juniata River and critical to the comprehensive flood control plan of the Susquehanna River basin. The original dam at Raystown Lake was completed in 1911 but was only 45 feet tall. A major flood in 1936, which devastated most of the Juniata and Susquehannock River valleys, illustrated the need for a new and larger dam. The current Raystown Lake and dam was authorized by the Flood Control Act of 1962 and completed in 1973, with a dam height of 225 feet and width of 1,700 feet. The waters and lands adjacent to the lake are now managed by the U.S. Army Corps of Engineers (USACE). The lake has approximately 8,100 surface acres, 118 miles of shoreline, and 29,000 acres of total project area.

During peak boating season, the existing boat ramp facilities operate at full capacity, and boat density on the water reaches high levels. **Figure 1-1** displays a photograph of peak boating at Raystown Lake around the Fourth of July holiday weekend. As lake managers, USACE is tasked with balancing economic, social, and personal uses of the lake with environmental goals. USACE desires to quantify current boat densities and to understand how that use level impacts crowding and safe boating conditions. Should densities be found to create safety and crowding concerns, USACE is interested in identifying actions that could improve safety such as speed limits, additional no wake zones, or restrictions on boat sizes or types.

The purpose of a carrying capacity study is to characterize "the level of use beyond which impacts exceed levels specified by evaluative standards" (Shelby and Heberlein 1986). The literature reviewed in preparation of this document suggests that carrying capacity is not a matter of computing a single maximum value of desired boating density but instead includes perceptions of recreational users and managers and site-specific management goals. The purpose of this study was to collect data on boating use of Raystown Lake and develop a range of recommended boating carrying capacities to assist lake managers with meeting demands on lake resources.

Figure 1-1. Raystown Lake July 7, 2018

1.1 Study Purpose

The purpose of this Raystown Lake boating carrying capacity study is to gather and process information, using statistical methods, about recreational boating use on Raystown Lake and the perception and preferences of boaters concerning management of the lake. USACE is currently in the process of

updating Raystown Lake's Master Plan (MP). This carrying capacity study is intended to provide data to support this plan revision by:

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

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 focus 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. 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).

In reviewing past studies, there are four main types of recreational carrying capacity: ecological, facility, spatial, and social (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.

Ecological carrying capacity refers to the ability of the ecosystem to cope with human impacts associated with recreational activities. These include impacts on wetlands and riparian communities, trash accumulation and pollution, soil erosion and shoreline damages, and loss of groundcover. Ecological carrying capacity also may 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 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 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 Federal Programs Corporation [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 usable surface water area for various types of boating activities. Spatial carrying capacity is the number of boats that comfortably and safely engaged in their chosen recreational activity within a specific area of the lake. Spatial boating carrying capacity considers the usable 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 nonpeak times may include on-the-water surveying, aerial flyovers, 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 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, depending 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 point data can provide insight into the number and types of watercraft on a lake during a time and general information on the point of origin. Watercraft are generally classified as speed boats, pontoon boats, fishing boats, personal watercraft (PWC), 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. 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, offers 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 incident 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 users' 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 surveys. These may include on-site field surveys at ramps and marinas, telephone surveys, and/or online and mail surveys. Generally, responses to on-site 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 gage users' perceptions of crowding (Bosley 2005; CDM Smith 2017).

On-site 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 General Overview of Calculating Carrying Capacity

Most studies include components of each of the types of carrying capacity described in the previous section. Overall and zone-specific optimum recreational boating carrying capacity is calculated for a specific lake based on the types of data collected during the study.

Approaches to calculating spatial carrying capacity are the most common type described in the literature. The following sections describe the methods used in previous studies. When appropriate data are collected, optimal carrying capacities would also be calculated for each additional component

analyzed. For example, optimal social carrying capacity could be determined via statistical analysis of coded survey responses.

1.3.1 Calculating Spatial Carrying Capacity

Calculating the optimal spatial carrying capacity of the lake is a key metric of assessing the overall recommended maximum boat density. This calculation will likely include use factors based on published optimum boating densities. The spatial capacity may include consideration of boat type ratios as determined from the field data of existing conditions. While many studies have suggested an optimal number of acres per boat or boat type, the estimates vary widely and often are dependent on one activity in isolation rather than in combination with other uses.

In a study of carrying capacity and lake user attitudes for three lakes in Oakland County, Michigan, Ashton (1971) identified optimum boating density ranges of 5 to 9 acres per boat, 4 to 9 acres per boat, and 6 to 11 acres per boat, depending on the lake. Jaakson et al. (1989) studied three lakes in north-central Saskatchewan and identified different boat densities, depending on the type of boat. This study also assumed an average of 10 acres per boat for acceptable safe boating. These conclusions were value judgements based solely on field observations, and the authors note that such findings are not readily transferable to other lakes. Furthermore, Jaakson et al. (1989) stated that carrying capacity values for other lakes should be calculated based upon the "morphology of a lake, cultural tolerances of density, and safety considerations of the manner in which water-oriented recreation activities are carried out." Wagner (1991) reported that, based on the viewpoints of many boaters, 1 boat per 25 acres of water surface is considered sufficient for all recreational boating activities (racing, fishing, skiing). Racers and water-skiers feel restricted at less than 10 acres per boat, and nearly all motorized watercraft users feel crowded at less than 5 acres per boat. Warbach et al. (1994) concluded that approximately 30 acres per motorboat (greater than 5 horsepower) is an appropriate boat density.

Olvany and Pitchford (2010) completed a study on Canandaigua Lake, which included a field survey to determine existing peak boat densities followed by development of a lake-specific carrying capacity using four methodologies. The final recommendation was a carrying capacity range of 15 to 20 acres per boat. The four methodologies used to arrive at this recommendation are described below.

- Carrying Capacity Analysis and Ordinances Providing Lake Access Regulations: This model for developing a carrying capacity was developed in Michigan and uses a scoring matrix that accounts for various characteristics of inland lakes. Scores for each characteristic fall under either a less restrictive or more restrictive carrying capacity. The differences in sums of the less restrictive and more restrictive categories are used to calculate overall carrying capacity. Characteristics considered include a lake shape factor, bottom soil type, and percentage of shoreline development. For Canandaigua Lake, the analysis resulted in a total carrying capacity of 38 acres per boat.

- Weighted Average Approach: This approach utilized suggested carrying capacities that were estimated given the minimum spatial requirements by boat type applied to the observed percentages of boats by type that were on the lake during peak day field observations. For Canandaigua Lake, this method resulted in an overall density of 12.6 to 16.8 acres per boat.

- Proportion of High-Speed Watercraft Approach: This approach used the percentage of high-speed watercraft from field observations in the equation: Carrying Capacity (in acres per boat) = 10 + 5 * (proportion of high-speed watercraft). This approach resulted in a suggested carrying capacity of 13.5 acres per boat for Canandaigua Lake.

- Water and Land Recreation Opportunity Spectrum (WALROS): The U.S. Bureau of Reclamation (Reclamation) WALROS approach was used for Canandaigua Lake. This approach uses expert opinion to assess the attributes of the lake and results in a lake classification that ranges from urban to rural with associated recommended boating densities for each classification. In general, WALROS captures social preferences and physical boating constraints based on the classifications. For Canandaigua Lake, it was classified in the mid-range of the spectrum resulting in a carrying capacity range between 15 and 35 acres per boat. The WALROS approach is explained in detail in Section 4.2.

A carrying capacity study completed on Deep Creek Lake in Maryland utilized yet another method for estimating lake-specific, optimal, spatial carrying capacity that involves multiplying zone-specific boat type ratios collected during field studies by published optimum boating densities (ERM, Inc. 2004). This study utilized the optimum boating densities proposed by Warren and Rea (1989). The results of this study are summarized in **Figure 1-2**.

		% Boat Use by Zone		
Type of Watercraft	Use Factor	North	Central	South
Motorboats -	9.0 acres per boat	59.8%	59.5%	50.3%
Boat fishing -	1.3 acres per boat	32.2%	32.0%	27.0%
Sailboats -	4.3 acres per boat	0.4%	2.1%	15.4%
Canoes/kayaks -	1.3 acres per boat	0.0%	1.0%	0.3%
Waterskiing boats -	12.0 acres per boat	7.6%	5.4%	7.0%

Figure 1-2. Deep Creek Lake Boat Use by Zone
Source: ERM, Inc. 2004

The final spatial carrying capacity calculation for each lake zone takes into consideration the zone's usable surface area, boat type, and watercraft use factor (density). Warren and Rea (1989) developed a set of equations that first divide each zone's usable acreage by the use factor per boat type to determine the maximum number of boats by boat type that should use that zone at any one time. The maximum number of boats is then weighted by the zone-specific percentage of boat use (per spatial analysis) to determine the estimated carrying capacity by boat type.

Similar calculations would be completed for each boat type and lake zone. Summations would be made to determine total lakewide optimal physical boating density. Optimal spatial carrying capacity estimates are often compared with suggested boating densities determined by the WALROS classification for the specific lake as a means of validating assumptions.

1.3.2 Calculating Social Carrying Capacity

There are no precise standards for determining social carrying capacity. Warren and Rea (1989) suggested that once 33 percent of respondents to photo simulations indicate that the pictured use level is sufficiently high to discourage boating, the carrying capacity has been reached. A study

completed in 2004 (ERM, Inc.) suggests that social carrying capacity limits are reached when mean crowding ratings approach 5 on a 9-point Likert scale and over 40 percent of boaters report experiencing moderate to high crowding levels.

Setting appropriate thresholds involves an understanding of the specific lake context and characteristics, boat type mix, and perhaps use history. Local focus groups might be helpful in identifying lake appropriate thresholds for social carrying capacity.

1.4 Utilizing Results

The final step in evaluation of carrying capacity involves comparing the recommended boating carrying capacity to the actual use or current boat density. Based on the difference between the existing condition and the estimated range of desired conditions, management goals and procedures may be adjusted. In addition, projected future conditions can be compared to the calculated optimal carrying capacity to evaluate alternative management plans.

Management actions could be taken to adjust the existing, or projected future, conditions to bring user densities closer to the estimated optimal carrying capacity condition. Such actions could include continued monitoring; expansion or reduction of recreational facilities, such as marinas, parking lots, private boat docks, or boat launches; restrictions on speed and horsepower; restrictions on PWC use; restrictions based on peak use times, such as holidays; or increased water patrol and law enforcement. Some studies have also analyzed the effects of future growth, considering population projections and expansion plans to estimate future lake use conditions (Bosley 2005).

A study conducted in Michigan by Progressive AE (2001) suggests activities for curtailing use of lakes in cases where capacity is limited or met. Management activities specific to boaters may include watercraft control ordinances, such as boating speed limits, establishment of wake controls, and curfew hours on high-speed boating activities. Limitations on renewal and expansion of marina facilities, restrictions on road-end use at public access facilities, and increased dissemination of information regarding boating laws coupled with aggressive enforcement can all be utilized to curtail future increases in use.

No single optimal carrying capacity standard will satisfy all lake users in all situations as users will have different perspectives on what constitutes crowding. In addition, each lake is unique, and identification of an overall optimum recreational boating capacity should consider site-specific attributes. The future projected conditions also must be evaluated to incorporate potential ecological, facility, and spatial impacts as well as user perspectives and opinions. The demand for various activities and the condition of the lake must be considered to set realistic goals and standards. Each component can be weighted based on overall project goals and objectives to determine an overall recreational boating carrying capacity.

1.5 Raystown Lake Study Approach

The overall goals of this study are 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 Raystown Lake to characterize the extent to which

boating falls within, under, or beyond the recommended capacity. CDM Smith collected additional information on existing facilities to inform lake managers about how facility capacity may affect carrying capacity goals. This study does not address the ecological carrying capacity at Raystown Lake.

Over three survey weekends during the summer of 2018, CDM Smith conducted field activities to gather data on boating activities. Data were collected the weekends prior to and following the Fourth of July (June 30 and July 7) and one weekend in August. 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. Empty marina slip counts were tabulated utilizing aerial photography. This field information provided the primary data on volume of boat traffic and origination of boats on the lake.

A user survey targeting boaters at Raystown Lake was administered following the summer boating period in the fall of 2018. The survey, approved by the U.S. Office of Management and Budget, follows the requirements and guidelines for federally sponsored data collections. 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. A total of 1,367 completed responses were received, resulting in a response rate of 38 percent, providing a statistically valid sample for the analysis. Results collected provide a 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 A.

A recommended carrying capacity benchmark range, expressed as acres per boat, was developed from several sources. The survey results were used to inform the calculation, taking into consideration the results of questions targeted toward safety and crowding thresholds. Information was assessed from the field collection such as boat types and boating activities found to be prevalent at Raystown Lake during peak boating times. Additionally, the WALROS calculation, developed by Reclamation (2011), was utilized. 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.

The recommended carrying capacity benchmark range was compared to observed boat densities as derived from the 2018 summer field collection. 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 use levels. From this information, lake managers can better plan for the future of Raystown Lake and strive for a healthy, safe, and balanced level of recreational boating.

1.6 Document Organization

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

- Section 2 describes the study area, including study zones, usable surface area, existing infrastructure, user characteristics (from the survey results), and visitation levels.
- Section 3 describes collected data on boating safety and crowding at Raystown Lake.
- Section 4 details results of the literature review and WALROS analysis used to inform the recommended ranges for boat density for Raystown Lake. It also presents the results of the user survey and perceptions related to safety, crowding, and displacement to derive the social carrying capacity.
- Section 5 describes the methodology and results of the field studies to characterize the existing boat density at Raystown Lake, including data on boat origin and facility capacity.
- Section 6 provides a summary of the analysis and conclusions about the existing carrying capacities for recreational boating at Raystown Lake.
- Section 7 lists the sources cited in the preparation of this report.

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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 include its physical features and the social and economic characteristics of the surrounding area and the lake's users.

2.1 Study Zones

For purposes of this study, data were collected, analyzed, and reported by study zones. The lake was divided into five study zones from north to south (**Figure 2-1**). The study zones were identified as areas that have differing physical characteristics that may relate to different patterns of boat use or management strategies. For example, the southern end of the lake (Zone 5) is narrow and can be shallow, making this area more attractive to fishermen, whereas the middle section of the lake (Zones 2, 3, and 4) contains wide spaces that allow for speed boats 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 for 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.

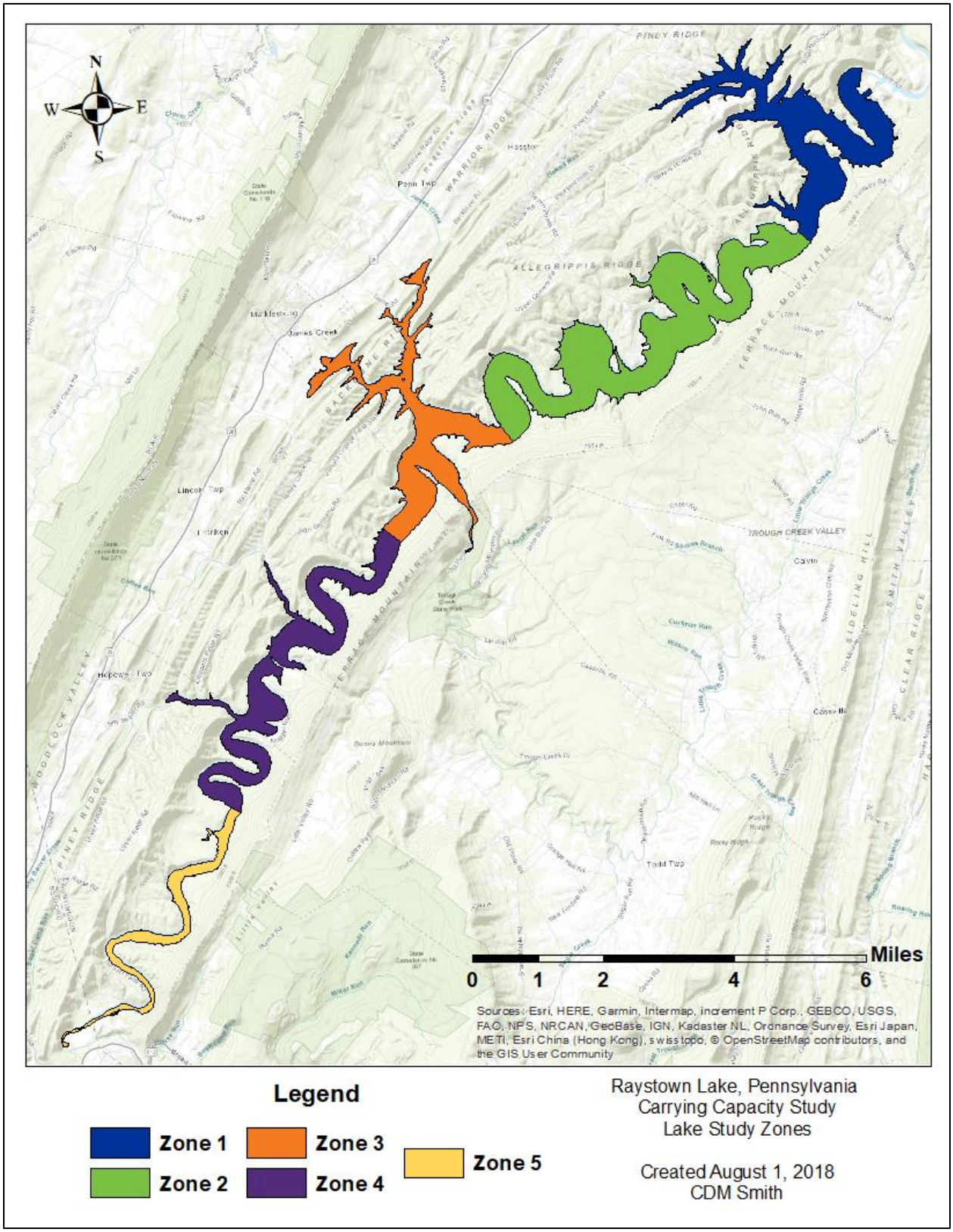

Figure 2-1. Lake Study Zones

2.2 Usable Surface Area

The calculation of boating density (acres per boat) relies on usable acres. The calculation of usable acres is total water acres minus restricted or unusable acres. CDM Smith calculated the total lake acres and usable areas for boating at Raystown Lake based on geographic information system (GIS) analysis. GIS analysis determined that the lake has a total area of 8,115 acres, excluding islands **(Table 2-1)**.

Table 2-1. Total Surface Acreage by Study Zone at Raystown Lake (Acres)

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
1,794	2,829	1,481	1,542	469	8,115

For this analysis, the unusable areas are equal to those that are designated restricted areas plus buffers around marinas and infrastructure. These areas include the Raystown Lake dam and spillway, Seven Points Marina, Lake Raystown Resort Marina, the Waterfowl Propagation Area, and the Juniata College Field Station Road Cove. Since the lake has a steep shoreline, there are not many beaches or locations in which people usually swim outside of the designated swimming areas. Also, the shoreline areas are used by boats for mooring and fishing. Therefore, the shoreline area was not buffered for this analysis, meaning that shorelines are considered usable surface area. The following outlines the unusable/restricted areas by study zone:

- The Raystown Lake dam and spillway have restricted space around them, which totals approximately 20.5 acres. The restricted areas are comprised of the 100-foot buffer from the dam and the area along the visitor pavilion, the small channel that leads to the gated spillway, and a 100-foot buffer along the coast south of the spillway until the tree line begins along the shore for an emergency overflow area (ungated spillway). This restricted area is in Zone 1.
- The Seven Points Marina, located in Zone 2, has 26 acres of unusable area.
- Just west of the Aitch boat launch ramp in Zone 3 is a restricted area designated the Waterfowl Propagation Area by the Pennsylvania Game Commission. This area is comprised of 42 acres.
- There is a restricted area referred to as the Juniata College Field Station Road Cove in Zone 3. It is approximately 1,000 feet south of mile marker J2 and across the river channel from mile marker J1. It has 9.5 acres of restricted space.
- The marina located at the Lake Raystown Resort in Zone 4 has additional unusable areas. The marina is located on a peninsula and has docks on both the north and south sides. The north side has an unusable area of 18 acres, and the south side has an unusable area of 5 acres, giving the total marina an area of 23 unusable acres.

The locations of the unusable or restricted areas can be seen in **Figure 2-2**, and total usable acres by study zone is shown in **Table 2-2**. The calculation of usable acres is the total lake area minus the restricted/unusable areas:

$$Usable\ Acres = 8{,}115 - 20.5 - 26 - 42 - 9.5 - 23$$

$$Usable\ Acres = 7{,}994$$

Table 2-2. Usable Acreage by Study Zone at Raystown Lake (Acres)

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
1,773	2,803	1,430	1,519	469	7,994

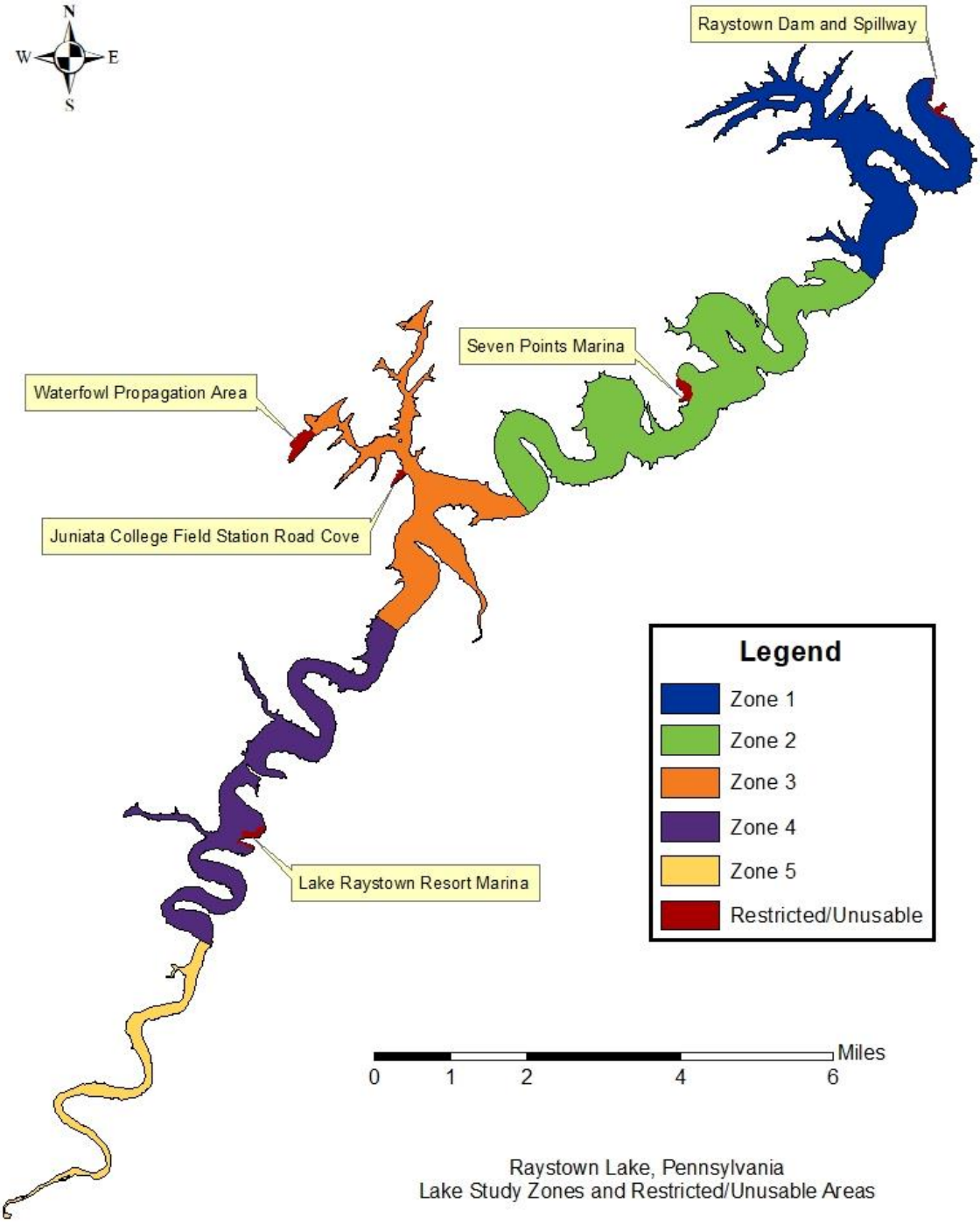

Figure 2-2. Map of Raystown Lake with Restricted and Unusable Areas

2.3 Existing Infrastructure

Water-based recreational activities are critically linked with infrastructure such as boat ramps, marinas, swim beaches, and docks. At Raystown Lake, there are five campgrounds with 650 campsites, 136 miles of trails, 10 picnic shelters with numerous additional picnic areas and tables, and over 21,000 acres open to hunting. Other amenities include an amphitheater; 10 boat launch ramps; and a resort complex with cabins, a water park, miniature golf, and a conference center. There are no private docks at Raystown Lake due to USACE owning most of the land surrounding the lake and the steep topography of the shoreline, which inhibits development. This section focuses on the land and water infrastructure that provides access to the lake, including marinas, resorts, public boat launches, and camping and recreation areas.

2.3.1 Marinas/Resorts

There are two marinas at Raystown Lake as shown in **Figure 2-3**. Marinas on Raystown Lake are privately owned and operated, full-service marinas and provide gasoline, slip rentals, food service, and watercraft rentals.

At Raystown Lake, only Seven Points Marina offers both dry and wet storage slips. Wet storage slips refer to boats that are docked on the water and ready for use, whereas dry slip storage involves removing the boat from the water (generally via a crane or lift) and storing the boat on a rack. The rack can be located indoors or outdoors. Seven Points Marina has an indoor rack facility with 285 dry slips and an additional 661 wet slips, for a total of 946 slips.

Lake Raystown Resort only offers wet storage slips. There are 650 wet slips at the marina, with 4 slips generally reserved for restaurant parking and 2 slips reserved for Pennsylvania Fish and Boat Commission (PFBC) boats. Between the two marinas, there are 1,311 wet slips and 285 dry slips at Raystown Lake, for a total of 1,596 slips (**Table 2-3**).

Additionally, both marinas have boat launch ramps. Seven Points Marina has one boat launch ramp with three lanes. Lake Raystown Marina has two separate boat launch ramps, one with two lanes and the other with three lanes.

Table 2-3. Number of Wet and Dry Slips at Marinas at Raystown Lake

Marina	Study Zone	Wet Slips	Dry Slips	Total Slips
Seven Points Marina	Zone 2	661	285	946
Lake Raystown Resort Marina	Zone 4	650	0	650
Total		**1,311**	**285**	**1,596**

Source: USACE 2018a

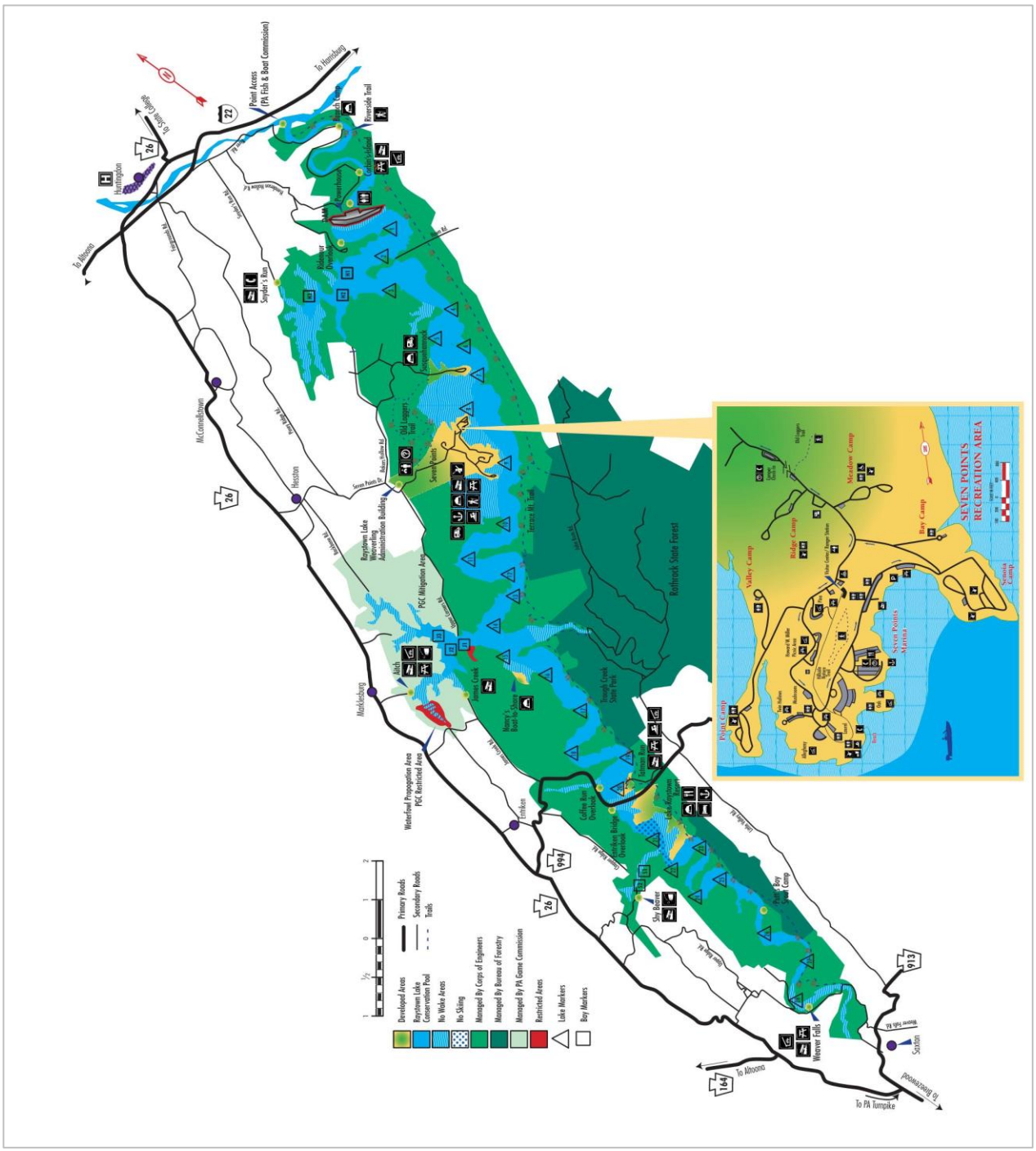

Figure 2-3. Raystown Lake Facilities
Source: USACE 2018b

2.3.2 Boat Launch Ramps

There are 10 public boat launches geographically dispersed throughout Raystown Lake as shown in **Figure 2-3**. One of the boat launches (Corbin's Island) is north of the dam and outside the study area. Of the remaining nine, six are in public recreation areas and three are outgranted to a non-USACE entity via license, easement, or other appropriate authorization. There is one private boat launch

(Heritage Cove) at the southern end of the lake. In total, there are 701 trailer spaces and 78 car-specific spaces available at USACE-managed boat launch sites. Trailer and car parking by USACE-managed launch site are shown in **Table 2-4**.

Table 2-4. Trailer and Car Parking by USACE-Managed Boat Launch at Raystown Lake

Boat Launch	Trailer Parking	Car Parking	Overflow Parking
Weaver Falls	37	26	N/A
Shy Beaver	147	N/A	N/A
Tatman Run	59	23	N/A
James Creek	148	N/A	N/A
Aitch	67	11	N/A
Seven Points	93	N/A	67
Snyder's Run	83	18	N/A

Source: USACE 2018c

2.3.3 Campgrounds

There are several campgrounds at Raystown Lake. Some of these areas are managed by USACE, and the remaining are managed by the State of Pennsylvania or outgranted to private entities. Of the two managed by USACE, Seven Points has 262 campsites and Susquehannock has 61 campsites. Parking spaces at the campgrounds are large enough to accommodate boat trailers; therefore, these areas were included in the field survey counts of empty trailers. However, the total number of trailer parking spaces per campground is not quantifiable, and it is not always the case that empty boat trailers are parked in the spaces, which indicates the spot is used for someone actively boating the lake. Therefore, parking capacity and access opportunities for these areas could not be determined. None of the recreation areas have parking spaces large enough for boat trailers, but some are close to the boat launch ramps and might result in cars parking in trailer spaces.

2.4 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 A. Ninety-four percent of survey respondents reside within Pennsylvania. The largest proportion of respondents reside in Huntington, at 6 percent, followed by Altoona at 4 percent, and Johnstown and Harrisburg each at 3 percent. Most respondents were frequent users of the lake, with over 60 percent engaging in boating activities more than 10 times per year. Additionally, approximately 46 percent of boaters keep their boat at a marina on the lake; the remaining 54 percent transport their boat to and from the lake and utilize the boat ramps.

Boating is the primary activity at Raystown Lake for 83 percent of respondents. Fifty-two percent of respondents indicated that they are very experienced in the operation of a boat, and only 3 percent indicated they were inexperienced. Over 35 percent of boaters indicated 10 years or less of experience specifically on Raystown Lake. Ninety-seven percent of respondents were boat owners while the remaining 3 percent borrow their boat.

Boating activities are varied, with the top response being relaxing or sunning (36 percent), followed by cruising (26 percent), fishing (24 percent), swimming (22 percent), and waterskiing (13 percent). Swimming and sunning are stationary uses.

When asked which zone is primarily used during an average recreational boating trip, Raystown Lake boaters indicated that Zone 2 is used the most often (33 percent), followed by Zone 1 (22 percent) and Zone 3 (16 percent). Zone 2 was also the primary zone for entry to the lake, with 48 percent of respondents indicating they generally enter the lake from this zone, followed by Zone 4 at 26 percent. As far as movement throughout the lake, over 57 percent of respondents indicated that they travel to the northernmost mile marker of the lake (Mile Marker 1), with varying responses on the southernmost mile marker.

As shown in **Figure 2-4**, the most commonly used boat types are pontoon (33 percent), speedboats (17 percent), and ski or wake boats (17 percent). Based on responses, over half of boats used by survey respondents on Raystown Lake are between 21 to 28 feet in length (57 percent), with an additional quarter of respondents primarily utilizing boats 16 to 20 feet in length (27 percent). Nine percent of respondents indicated primary use of a boat larger than 29 feet in length while 6 percent indicated use of a boat less than 16 feet in length.

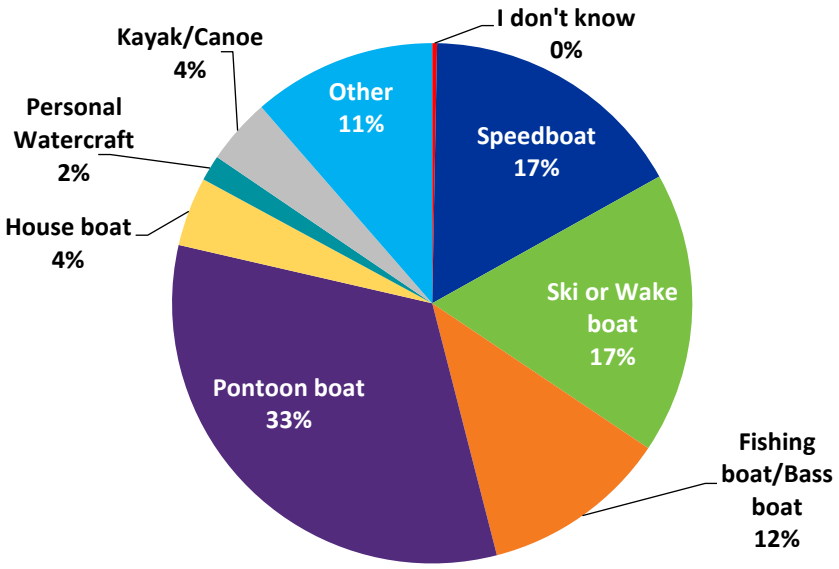

Figure 2-4. Primary Boat Types Used at Raystown Lake

2.5 Visitation

Visitation data, shown in **Table 2-5**, were provided by USACE for fiscal years 2014 through 2017. Since 2014, there has been steadily increasing annual visitation at Raystown Lake. Total visits have increased by 15 percent over the four years. In addition to fishing and boating activities on the lake, visitors participate in camping, hunting, hiking, swimming, scuba diving, and sightseeing.

Since 2006, Raystown Lake has hosted an average of 121 fishing tournaments per year (**Table 2-6**). The number of tournaments has increased gradually since 2008/2009. There are small and large tournaments, which are defined as tournaments with less than 50 boats and more than 50 boats,

respectively. Most of these tournaments are hosted at the James Creek Boat Launch (Zone 3) and the Aitch Boat Launch (Zone 3).

Table 2-5. Raystown Lake Visitation Data

Year	Day Use Visits	Overnight Visits	Total Visits
2014	901,677	203,147	1,104,824
2015	1,102,100	126,259	1,228,359
2016	988,010	265,114	1,263,124
2017	988,123	281,611	1,269,734

Source: USACE 2019

Table 2-6. Fishing Tournaments at Raystown Lake

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Small	98	85	86	97	103	107	107	117	120	139	134	123
Large	15	15	10	11	11	8	11	8	8	9	10	18
Total	113	100	96	108	114	115	118	125	128	148	144	141

Source: USACE 2014, 2018d

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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 conditions and realities of crowding and safety at Raystown Lake. This section summarizes the data available to assess safety and boating conditions at Raystown Lake.

3.1 Boating Incident Summary

Existing data on boating incidents, injuries, and fatalities at Raystown Lake were collected and analyzed for trends in frequency based on day of the week, month, and crowding versus non-crowding-related incidents for the entire lake and each study zone. The boating incident data were acquired from the PFBC for the 20-year time span of 1998 to 2017. Pennsylvania regulations require that an incident report be filed any time an incident results in a death or disappearance or an injury that requires more than first aid, when property damage is greater than $2,000, or when a complete loss of a vessel occurs. With that in mind, it is possible that the reported incidents underrepresent the true number of boating incidents.

At Raystown Lake, there have been a total of 144 reported incidents over the past 20 years, or an average of 7 per year. Of those, 37 resulted in no bodily harm. The remaining 107 incidents resulted in either injury, fatality, or, in some cases, both injury and fatality. In total, 101 incidents had reported injuries resulting in 124 injured people. Eight of the incidents resulted in 11 fatalities. Thus, reported boating incidents at Raystown Lake result in some form of bodily harm 74 percent of the time, no injury or fatality 26 percent of the time, and injury only 69 percent of the time (**Figure 3-1**).

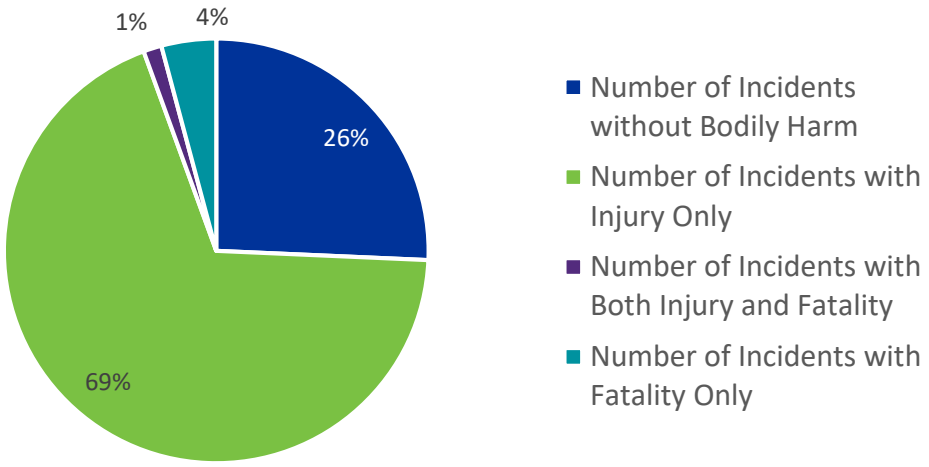

Figure 3-1. Number of Incidents and Bodily Harm at Raystown Lake (1998–2017)
Source: PFBC 2018

Because peak use times for Raystown Lake are summer weekends and holidays, it is expected that these times will have the highest records of incidents. This was confirmed by analysis of the incident data, with Saturday (60 incidents) and Sunday (39 incidents) the 2 days with the highest incident counts **(Figure 3-2)**. The summer months of June (28 incidents), July (50 incidents), and August (36 incidents) are the months with the highest incident counts **(Figure 3-3)**. There were no reported incidents from November through March. Incidents by year are relatively consistent except for 2 years; 2001 had 12 incidents, which is the highest number per year in the 20 years of analyzed records, and 2006 had only 1 incident. The other years between 1998 and 2017 had a range of 5 to 10 incidents per year **(Figure 3-4)**. The average number of incidents were 7.2 per year over the 20-year period of analysis. On average, five of those result in bodily harm.

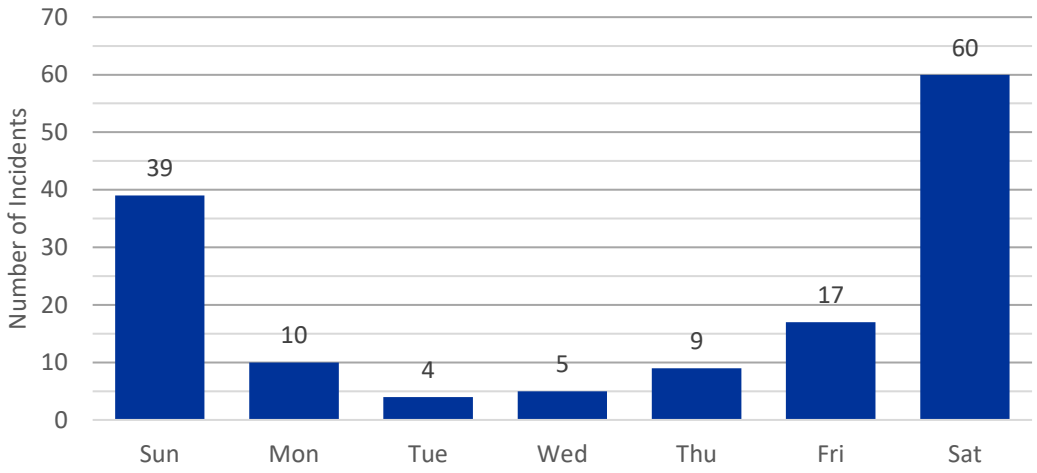

Figure 3-2. Total Boating Incidents by Day of the Week at Raystown Lake (1998–2017)
Source: PFBC 2018

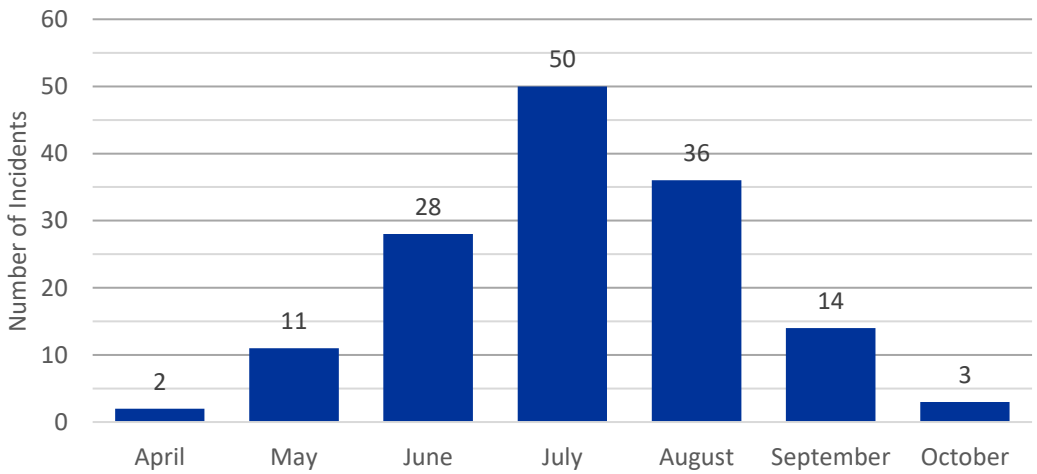

Figure 3-3. Total Boating Incidents by Month at Raystown Lake (1998–2017)
Source: PFBC 2018

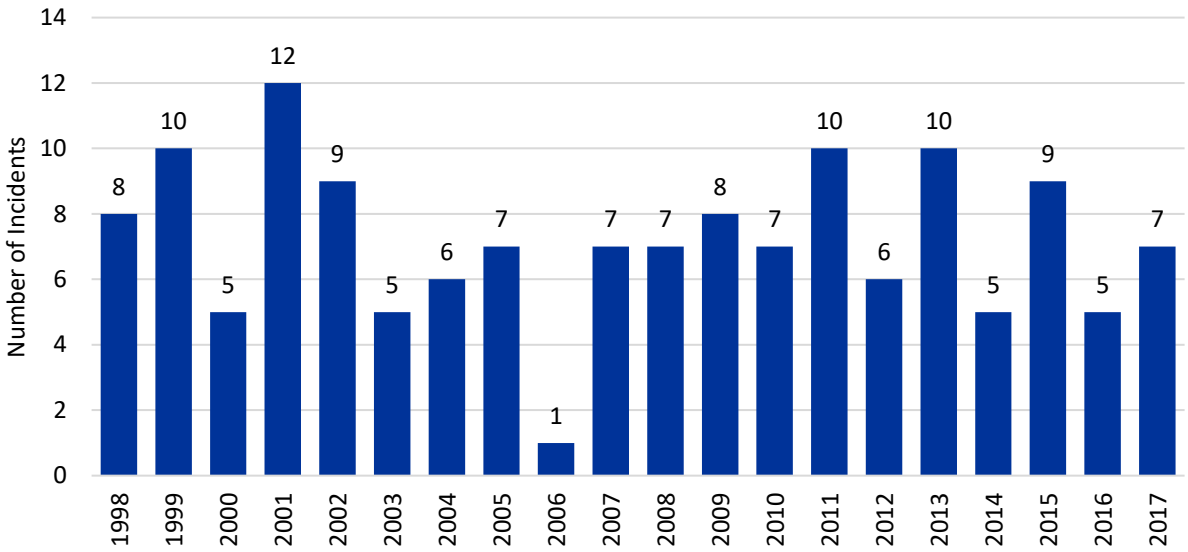

Figure 3-4. Total Boating Incidents by Year at Raystown Lake (1998–2017)
Source: PFBC 2018

3.1.1 Crowding-Related Boating Incidents

Crowding-related incidents are defined as any incident that could have been avoided if another occupied boat was not in the vicinity. Crowding-related incidents require two or more boats to be near each other for the incident to have to occurred. Crowding incidents include boat-on-boat incidents (except if one of the boats was docked at a marina), boat-on-wake incidents (except PWC that purposely use other boat's wake for jumping/launching into the air), and boat-on-tube incidents. Non-crowding-related incidents are defined as any incident that did not involve the presence of another occupied boat in the vicinity. Non-crowding incidents include boat fires and explosions; boat-on-dock incidents; capsized boats; boats that were sinking due to malfunction; boating incidents caused by weather-related waves; boats hitting submerged and nonsubmerged objects; boats running ashore (grounding); passengers falling overboard; and swimming, skiing, and tubing incidents not involving a second boat.

Between 1998 and 2017, there were 57 incidents at Raystown Lake resulting from crowding. This accounts for 40 percent of all reported incidents during that time frame. Out of the 57 crowding-related incidents, 39 resulted in injuries (68 percent), with 47 people hurt in those incidents. None of the fatal incidents at Raystown Lake were the result of a crowding-related incident. As shown in **Figure 3-5**, Zone 4 had the most crowding-related incidents (21), followed by Zone 2 (14). There were seven crowding-related incidents without a known geographic location. Temporally, crowding incidents have declined slightly since 2002 and currently average two to three per year as shown in **Figure 3-6**.

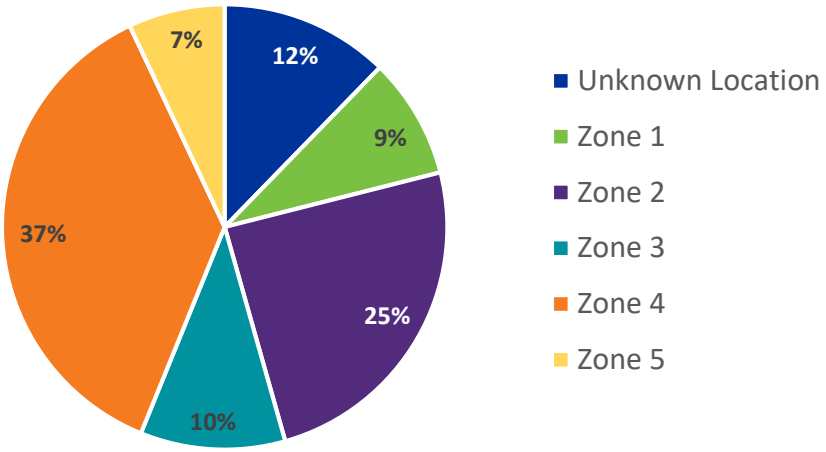

Figure 3-5. Total Number of Crowding-Related Incidents by Study Zone at Raystown Lake (1998–2017)
Source: PFBC 2018

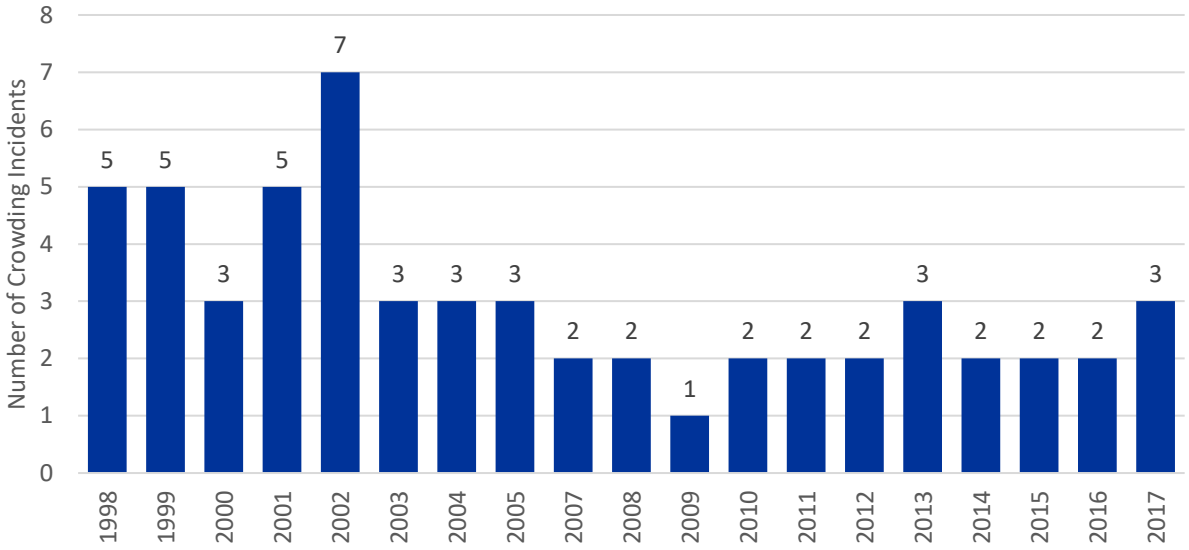

Figure 3-6. Number of Crowding-Related Incidents per Year at Raystown Lake (1998–2017)
Source: PFBC 2018

Crowding-Related Incidents by Study Zone

Figure 3-7 presents the crowding-related incidents spatially by zone. Over the past 20 years, Zone 1 had five reported incidents related to crowding, which accounts for 9 percent of all reported crowding-related incidents at Raystown Lake during that time. Three of the five crowding-related incidents resulted in injury, with four people injured in those incidents. Two of the incidents were related to tubing, two to operator error, and one was caused by a boat turning too quickly to avoid a collision with another boat and capsizing. Spatially, most of the crowding-related incidents occur near

the only boat launch ramp in Zone 1 (Snyder's Run) or the narrow channel that connects the main body of the lake to the small branches of the river, which include the boat launch ramp.

Zone 2 had 14 incidents related to crowding from 1998 to 2017, which accounts for 25 percent of all crowding-related incidents at Raystown Lake. Ten of the 14 crowding-related incidents resulted in injuries, with 11 people being injured. The main cause of crowding-related incidents and injuries in Zone 2 is large wake from other boats that causes passengers to fall or be ejected from the boat. There were also several cases of boats following too closely, which led to collisions and two cases of boating under the influence of alcohol (BUI). Spatially, five of the crowding-related incidents in Zone 2 occurred near Seven Points Marina. A further six incidents occurred between mile markers 6 and 8. The no wake zone in the northwestern section of the river segment between mile markers 7 and 8 has had no recorded incidents in the last 20 years.

Zone 3 had 6 incidents related to crowding, which accounts for 10 percent of all crowding-related incidents at Raystown Lake. Three of the six crowding-related incidents resulted in injuries, with three people being injured. Wake from large boats accounted for half of the crowding-related incidents and injuries. Boats colliding due to inexperienced operators accounted for another two of the incidents, and there was one incident where a boat ran aground trying to avoid a collision with another boat. Similar to Zone 3, crowding-related incidents were fairly dispersed across the zone.

Zone 4 had 21 incidents related to crowding, which accounts for 37 percent of all crowding-related incidents at Raystown Lake. Fifteen of the crowding-related incidents resulted in injuries, with 18 people being injured. Collisions were the main source of crowding-related incidents in Zone 4, occurring 11 times. BUI was a factor in one of those incidents. Wake from large boats caused passengers to be ejected or fall within the boat and sustain injuries in nine other crowding-related incidents. The segment of river between mile markers 19 and 20 is one of the highest incident-prone areas of the lake, with a total of seven incidents over the past 20 years. Zone 4 contains two public boat launch ramps and the Lake Raystown Resort and Marina, making this a popular area of the lake.

Zone 5 had four incidents related to crowding, which accounts for 7 percent of all crowding-related incidents at Raystown Lake. All four of the crowding-related incidents resulted in injuries, with five people being injured. Three of the four crowding-related incidents involved PWC collisions, and the other resulted from a water-skier unintentionally hitting multiple boats' wake. Spatially, the crowding-related incidents are clustered between mile markers 25 and 26. This is most likely because the river is narrower in this area and is a no wake zone after mile marker 28. This area is also the location of the only boat launch ramp in the zone (Weaver Falls).

There were seven incidents with no known geographic location related to crowding, which accounts for 12 percent of all crowding-related incidents at Raystown Lake. Of the seven crowding-related incidents with unknown locations, four resulted in injuries, with seven people injured in those incidents. Four of the incidents were collisions, with two resulting from reduced visibility in poor weather conditions. Wake from large boats caused passengers to fall and sustain injuries in one incident and capsized a fishing boat in another incident. A water-skier trying to avoid another boat was the cause of the other crowding-related incident.

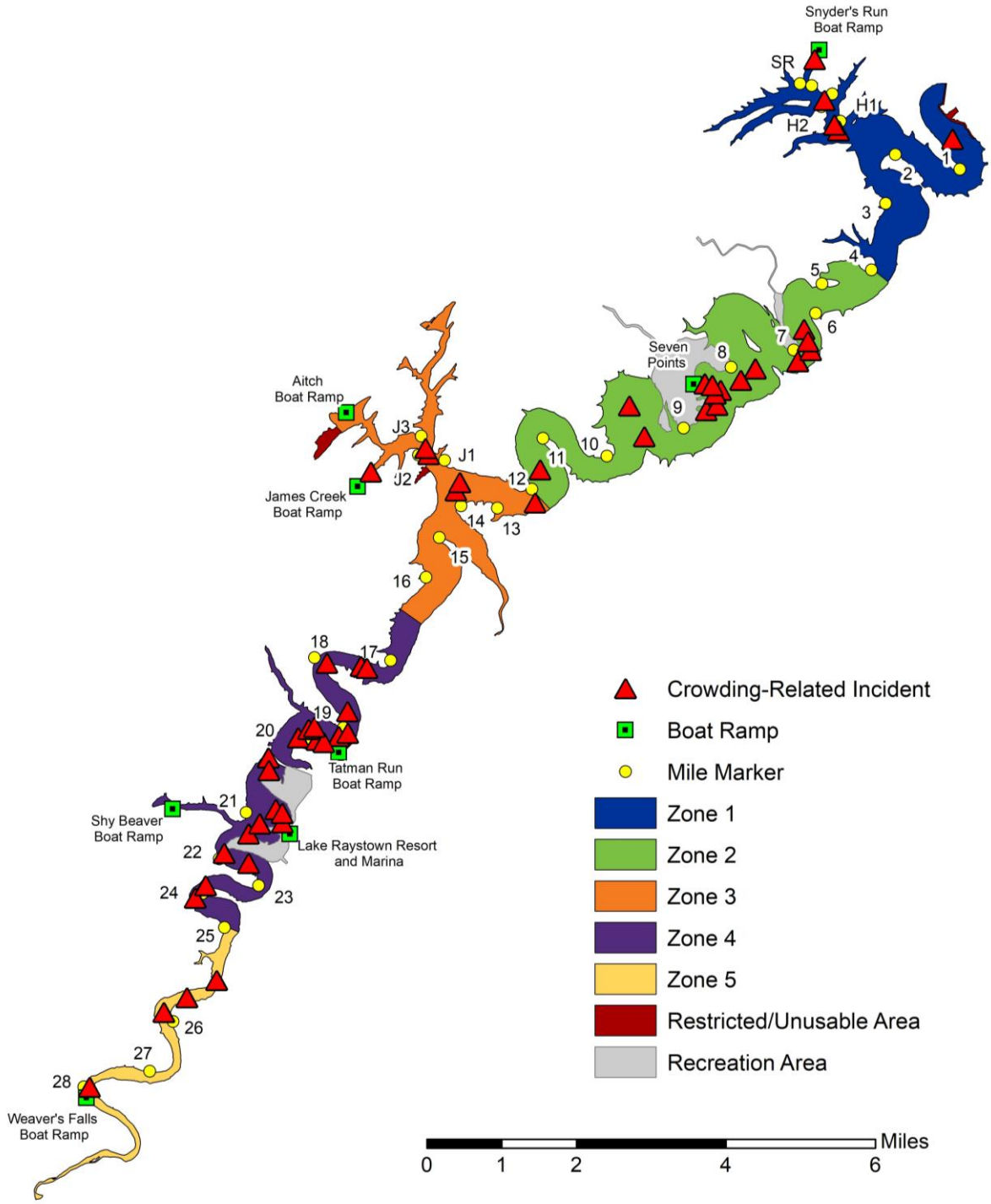

Figure 3-7. Map of Crowding-Related Incidents at Raystown Lake (1998–2017)
Source: PFBC 2018
Note: There are seven crowding-related incidents with unknown locations.

Crowding-Related Incident Rate by Study Zone

The rate of crowding-related incidents per 1,000 usable acres was calculated to determine if more incidents occur in one study zone over another when the data are normalized for the relative area of the study zone. As shown in **Table 3-1**, Zone 4 has the highest incident rate at 13.8 crowding-related incidents per 1,000 usable acres.

Table 3-1. Crowding-Related Incident Rate by Study Zone at Raystown Lake (1998–2017)

Study Zone	Usable Acres	Crowding Incidents	Crowding Incidents Per 1,000 Usable Acres
Zone 1	1,773	5	2.8
Zone 2	2,803	14	5.0
Zone 3	1,430	6	4.2
Zone 4	1,519	21	13.8
Zone 5	469	4	8.5
Total (Including Unknown Locations)	7,994	57	7.1

Note: Seven crowding-related incidents have no known geographic location.

Crowding-Related Incidents by Day of the Week and Holidays

Of the 57 crowding-related incidents, 38 (or 67 percent) occurred on a Saturday or Sunday. Another four incidents that did not occur on weekends occurred either on July 4 or within 1 day. Combined, weekend and holiday crowding-related incidents accounted for 74 percent of all crowding-related incidents.

Crowding-Related Incidents by Month

The incident data were analyzed by month to determine what time of year is the most prevalent for crowding-related incidents. As expected, the summer months of June, July, and August have the highest number at a total of 47, or 82 percent, of incidents reported over the 20-year period. The busiest month of the year, July, had the highest number of total reported crowding-related incidents from 1998 to 2017 (22) followed by August (17).

3.1.2 Boating Under the Influence

BUI of alcohol and/or drugs is a major safety concern for all USACE-managed lakes. According to research from the U.S. Coast Guard, approximately 23 percent of fatal boating incidents are a result of BUI (Lawrence et al. 2006). Two of the eight fatal incidents at Raystown Lake between 1998 and 2017 had alcohol as a contributing factor. These 2 incidents resulted in 4 of the 11 fatalities (36 percent) at Raystown Lake during the period analyzed. BUI enforcement at Raystown Lake is mainly handled by the PFBC, with additional enforcement from the Huntingdon County Sherriff's Department between May and September. The number of BUI arrests by year can be seen in **Figure 3-8**.

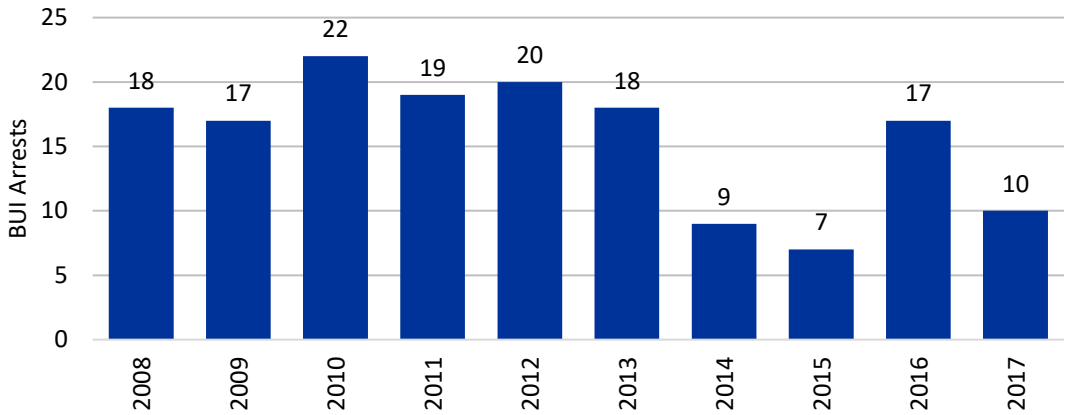

Figure 3-8. Number of BUI Arrests at Raystown Lake (2008–2017)
Source: USACE 2018d

3.2 1988 Boating Capacity Study at Raystown Lake

Over the summer of 1987, a study was conducted on Raystown Lake to understand peak boat use patterns and their effect on boating quality on the lake. The research team from the Department of Recreation and Parks at Pennsylvania State University documented use densities and visitor perceptions of the conditions during peak use periods to evaluate the acceptability of existing peak use boating conditions and predict the likely consequences of facility development on the lake (Graefe et al. 1988).

The research team used a combination of survey procedures. Peak use boat densities were identified through aerial photography and ground counts of vehicles at major access points. On-site personal interviews conducted at major access points during ground counts captured visitor perceptions. Eight days over the summer season were sampled, including one over Memorial Day weekend and one over the Fourth of July weekend.

The study found that overall use levels between 1 and 3 p.m. ranged from 10.5 to 7.5 acres per boat, a range of 794 to 1,101 total boats on the water at one time. The lowest densities were found in August while the highest were over the Fourth of July holiday. Regarding user perceptions, they found that boaters tended to feel most crowded while out on the lake and least crowded at the access points at the start of their trips. About one-quarter of respondents reported avoiding their favorite parts of the lake due to crowding. Few boaters were bothered by noise on the lake, but about one-quarter reported that the behavior of other boaters (e.g., going too fast, coming too close, not observing no wake zones) interfered with their enjoyment.

The study also looked at correlations between boat density and perceptions and found significant associations between boat density and perceived crowding on the lake, perceptions of safety, and various types of displacement (i.e., avoiding the lake or certain areas of the lake). The study found that the perception that boating was safe was the most significant indicator.

Overall, the study concluded that current peak use conditions were acceptable to most boaters. The following summarizes the key findings and recommendations from the 1988 Raystown Boating Capacity Study:

- Conditions might be improved by focusing management on the indicators with the greatest influence on satisfaction. For example, rangers might work to increase enforcement and education of boaters to reduce dangerous behaviors such as driving too fast or close.
- Additional parking spaces at boat ramps and the development of a new ramp would have the most direct influence on peak use rates.
- Increased marina capacity would increase density but to a lesser degree.
- An increase in the number of campsites would have little impact on boating density.
- The 1988 study should be considered the baseline and used for understanding and monitoring boating density. To monitor boat density, rangers should be stationed at major access points.
- The most important indicators for future monitoring should include a 10-point satisfaction measure, perceived crowding while on the lake, perceptions of safety and boats coming too close, and various types of displacement.
- A more in-depth visitor survey should be conducted every 5 years.

3.3 Parking Citations

When boat launch parking lots become full, boaters at Raystown Lake will sometimes choose to park illegally. This can lead to overcrowded conditions on the lake and environmental degradation of the surrounding land when trailers are parked on grass and other vegetation. Parking citations, shown in **Figure 3-9**, have declined overall since 2012, indicating that fewer boaters are parking illegally. Warnings and citations for all violations, shown in **Figure 3-10**, have changed over time, mostly due to changes in regulations such as the elimination of the user fee program in 2011 and rangers' efforts to resolve issues rather than issue warnings. The preferred ratio of warnings to citations is 3:1, and the national average is 2:1. Since 2009, Raystown Lake has maintained a ratio of less than 3:1 (USACE 2018d).

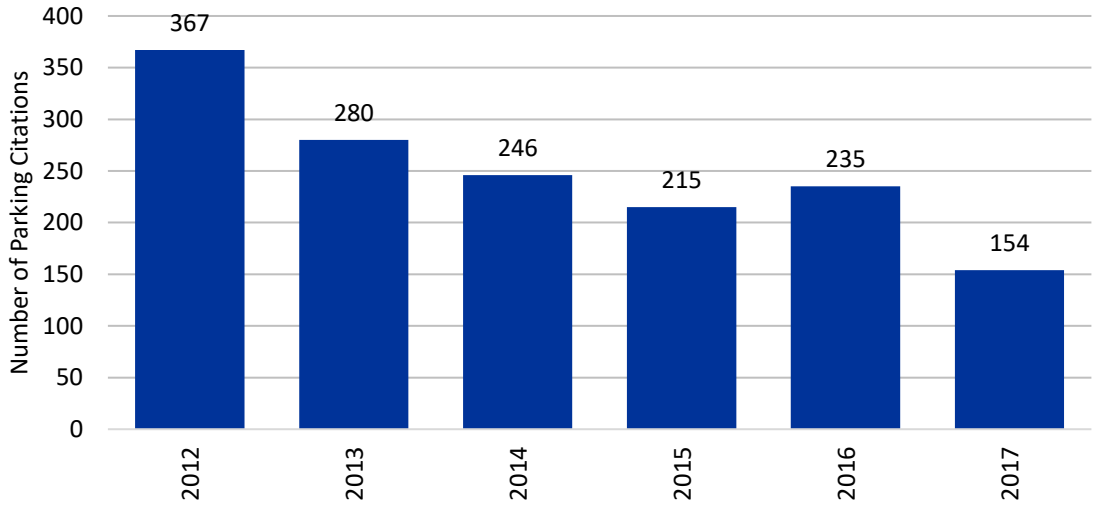

Figure 3-9. Number of Parking Citations Issued at Raystown Lake (2012–2017)
Source: USACE 2018d

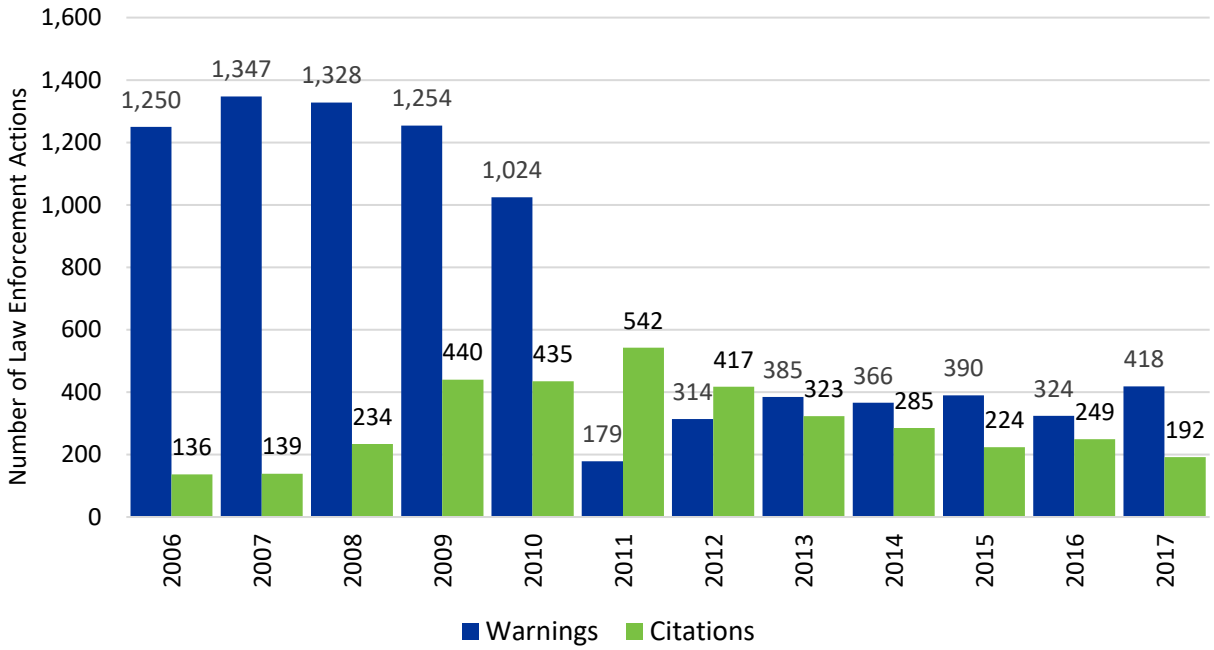

Figure 3-10. Number of Warnings and Citations Issued at Raystown Lake (2006–2017)
Source: USACE 2018d

3.4 Boat Launch Capacity Days

The USACE Project Office staff at Raystown Lake collects data on boat launch capacity days, which are defined as days when a parking lot at a boat launch ramp is at maximum capacity. The total number of boat launch capacity days, shown in **Figure 3-11**, often corresponds to warm weather and clear skies as noted by the USACE staff (USACE 2014). This could explain the variability between years in boating capacity days.

Seven Points swim beach parking lot reaches maximum capacity several times per year. In 2017, the capacity reached a level not seen in at least 25 years when on July 2 all parking lots filled to the point that rangers were stopping cars and turning visitors away. Clear, sunny skies and a holiday weekend stretched the resources of the facilities and USACE staff. Seven Points campground is one of the highest revenue-generating campgrounds managed by USACE in the country (USACE 2018d).

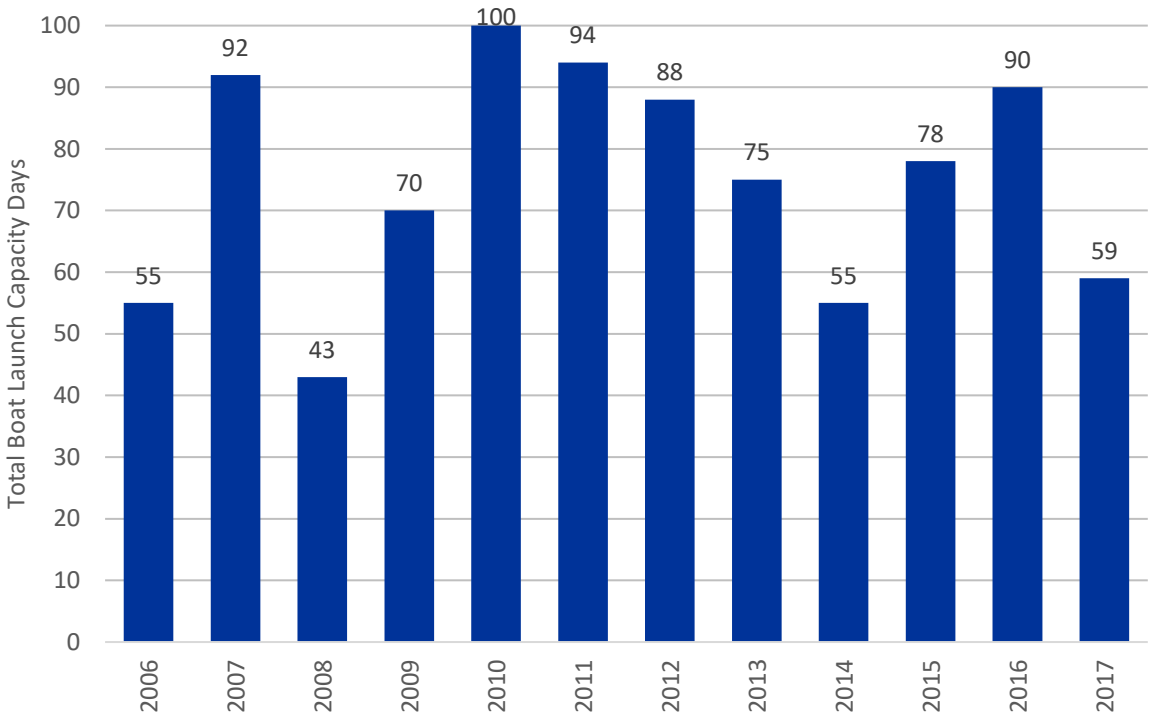

Figure 3-11. Number of Boat Launch Capacity Days at Raystown Lake (2006–2017)
Source: USACE 2018d

3.5 Master Plan Comments

The Master Plan revision included an extensive public involvement effort, resulting in the collection of over 1,000 comments. These comments are discussed in Chapter 7 of the Master Plan, Agency and Public Coordination, and included in the plan as an Appendix.

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Section 4
Carrying Capacity Benchmarks for Raystown Lake

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 incidents involving other boats, boat type and speed, and dominant boating activities.

The WALROS methodology developed by Reclamation (2011) 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. A literature review was conducted to identify a range of recommended boating densities for other lakes, which will provide the framework for the current study (Section 4.1). The WALROS calculation for Raystown Lake is provided in Section 4.2. Similarly, the results of the boating survey were used to assess the social carrying capacity benchmarks at Raystown Lake (Section 4.3). The WALROS method result, information regarding recommended densities from other studies, and the social preference for boating density (collected through the survey) were all utilized to determine an appropriate boating range for Raystown Lake.

4.1 Boat Density Ranges from Literature and Other Studies

Key results from published boating capacity studies are summarized in **Table 4-1**, with emphasis on recommended boat density, calculated peak boat density, usable area, and a description of the lake that provides insight into any unique aspects of a lake, common recreational activities or events, and proximity to highways or major urban areas. The overall recommended average from these studies is 12.5 acres per boat, with a range of 3.5 to 22. Those lakes in the lower density range are mostly small reservoirs with a high level of development around the lake. Deep Creek Lake, located in rural Maryland, is similar to Raystown Lake and the closest in proximity. The lake has an observed peak density of 4.9 acres per boat, with a recommended max density of 8.4. PWCs are limited on that lake, and the number of access points is controlled.

Examples of published optimum boating densities from numerous boating capacity methodology literature are shown in **Table 4-2.** The combined average of these published optional densities is 16.8 acres per boat with a vast range, which is primarily dependent upon the type of boating activity.

Table 4-1. Summary of Carrying Capacity Ranges from Recent Studies

Lake Name	Location	Operator	Year	Lake Acres	Usable Acres	Peak Boat Count	Calculated Peak Density (acres/boat)	Recommended Density (acres/boat)	Lake Description
Eufaula Lake	Eufaula Lake, Oklahoma	USACE	2012	105,500	52,218	2,174	24	15	*Rural Developed*. Located on the Canadian River, about 90 minutes from Tulsa and 2 hours from Oklahoma City. Easy access from I-40, Oklahoma State Highway 9, and US-69. Largest capacity lake in Oklahoma, with over 800 miles of shoreline. Hosts an average of 56 fishing tournaments annually that draw large numbers of anglers and boats. Has 1,100 marina slips, 1,000 campsites, 82 picnic sites, 33 public boat ramps, 15 miles of trails, and 93 miles of roadways that provide access to the lake. Several other lakes in the area help spread out recreational users and reduce peak boat numbers.
Deep Creek Lake	Garrett County, Maryland	Maryland Department of Natural Resources	2003	3,628	2,939	600	4.9	8.4	*Rural Developed*. Largest inland body of water in Maryland. US Highway 219 passes over the lake, making it a short trip from the Pittsburgh area. Over 20% of homeowners are from Pittsburgh and 20% from the Washington D.C. area. PWCs are not allowed on the lake during peak hours during summer weekends and holidays. Ratio of boat types is 65% fast-moving boats to 35% slow-moving/fishing boats. Limited public boat ramps.
Canandaigua Lake	Canandaigua, New York	Canandaigua Lake Watershed Council	2008	10,553	9,560	974	9.8	15–20	*Suburban*. Located in the Finger Lakes region of western New York, 25 miles south of Rochester. Highway 20 passes just north of the lake through the town of Canandaigua, NY. More than 95% of the shoreline is in private ownership. The second most expensive lakefront property in the United States (behind Lake Tahoe). Proactive lake management has maintained a high level of water quality. Total lake area was used in the study because of community input stating that boats come within 100 feet of the shore to fish (which would give a density of 10.8 acres/boat).

Table 4-1. Summary of Carrying Capacity Ranges from Recent Studies (continued)

Lake Name	Location	Operator	Year	Lake Acres	Usable Acres	Peak Boat Count	Calculated Peak Density (acres/boat)	Recommended Density (acres/boat)	Lake Description
Pinecrest Lake	Pinecrest, California	U.S. Forest Service	2010	300	235	92	2.55	3.5–4.3	*Rural*. Located within Stanislaus National Forest in the Sierra Nevada Mountains, just off CA-108. Lakewide 20 mile per hour (mph) speed limit; no waterskiing possible. Small reservoir that is mainly used for swimming, motorboats, sailboats, and canoes/kayaks. No PWC allowed. Due to the low speed limit and smaller-sized boats used at the lake, a lower boating density is appropriate. Topography prevents additional facilities from being constructed.
Lake Ripley	Oakland, Wisconsin	Lake Ripley Management District	2003	418	302	49	6.16	18	*Suburban*. Located 25 miles east of Madison and 60 miles west of Milwaukee, WI. Small lake used mainly for fishing in the morning; speedboats and pontoon boats in the afternoon/evening. Peak boat counts occur several times throughout the summer on busy weekends and holidays. Ratio of slow-moving and stationary to fast-moving watercraft of 1.5:1 (60% vs. 40%). PWC account for 11% of boats.
Raystown Lake	Huntingdon County, Pennsylvania	USACE	1987	8,300	N/A	1,101	7.5	N/A	*Rural Developed*. Located between Pittsburgh and Harrisburg, PA. Close to I-99 and I-76. Popular fishing and powerboating destination but not desirable for sailing due to topography. Contains 594 campsites, 10 boat launches, 2 full-service marinas, 68.5 miles of trails, 10 picnic shelters, an amphitheater, a resort complex, 21,000 acres open to hunting, and 8,300 acres open to fishing.
Pine Lake	Plainwell, Michigan	Four Township Water Resources Council	2000	660	513	115	4.46	12.25	*Suburban*. Located about 20 miles north of Kalamazoo, MI. The lake has 12.1 miles of shoreline; 545 houses, with an average of 1.9 boats per house; 2 marinas; and 1 public boat ramp with 10 parking spaces. The only portion of the shoreline that is not developed is a section of emerging wetlands in the northeast corner of the lake. Most of the homes are rentals or seasonal/weekend residences.

Table 4-1. Summary of Carrying Capacity Ranges from Recent Studies (continued)

Lake Name	Location	Operator	Year	Lake Acres	Usable Acres	Peak Boat Count	Calculated Peak Density (acres/boat)	Recommended Density (acres/boat)	Lake Description
Upper Crooked Lake	Delton, Michigan	Four Township Water Resources Council	2000	645	478	53	9.02	12.25	*Suburban*. Located about 20 miles north of Kalamazoo, MI, near Michigan State Highway 43. Popular fishing location. The lake has 13.8 miles of shoreline; 250 houses, with an average of 1.5 boats per house; 1 marina; and 1 public boat ramp with 18 parking spaces. Moderately developed shoreline, but emerging wetlands in various locations prohibit further development. PWC only make up 6.8% of total watercraft on the lake (national average of 10 to 15%).
Gull Lake	Kalamazoo County, Michigan	Four Township Water Resources Council	2000	2,047	1,885	236	7.99	13.5	*Suburban*. Located about 15 miles northeast of Kalamazoo, MI, near Michigan State Highway 43. The lake has 13.4 miles of shoreline (all of which has been developed); 719 houses, with an average of 2 boats per house; 8 marinas, with 1 public boat ramp; and one private boat ramp that charges a small fee, with parking for 70 cars with trailers. The lake's size and expansive area of open water make it conducive to sailing and high-speed boating activities. Sailboats make up 13.5% of boats on the lake, and each year dozens of sailboat races are held.
Sherman Lake	Ross Township, Michigan	Four Township Water Resources Council	2000	153	118	33	3.57	11.5	*Suburban*. Located about 15 miles northeast of Kalamazoo, MI, and within proximity to I-94. The lake has 2.9 miles of shoreline; 95 houses, with an average of 1.9 boats per house; and one public boat ramp with 30 parking spaces. Small size of the lake prevents extensive PWC use.
Beaver Lake	Benton/ Carroll Counties, Arkansas	USACE	2016	28,299	24,401	1,450	16.8	10–20	*Suburban*. Located in the Ozark Mountains of northwest Arkansas, near I-49. The lake has 490 miles of shoreline, 7 resorts, 12 developed parks, over 650 individual campsites, 76 public boat launches, 711 trailer and car parking spaces, and 1,800 private docks with over 5,000 slips. Popular for waterskiing (40% of boats) and pontoon boats (26%) but not sailing (2%). PWC use is slightly below average at 8% of total watercraft (USACE-managed lakes average about 12%). Boat ramps and marinas account for 42% and 43% of watercraft origin, respectively, and the other 15% from private docks. Had 16 reported crowding-related incidents over 6 years.

Table 4-1. Summary of Carrying Capacity Ranges from Recent Studies (continued)

Lake Name	Location	Operator	Year	Lake Acres	Usable Acres	Peak Boat Count	Calculated Peak Density (acres/boat)	Recommended Density (acres/boat)	Lake Description
Stagecoach Reservoir	Oak Creek, Colorado	Colorado Parks and Wildlife	2010	780	685	44	15.6	15–18	*Rural Developed*. About 3 hours west of Denver, CO. Moderate level of facilities available but in a remote location. Half of the lake area is wakeless zone, and the other half is wake zone. Drawdown in summer water levels can impact carrying capacity significantly. Peak use puts lake at or slightly above recommended density but is at a lower density for most of the summer.
Tims Ford Reservoir	Franklin/ Moore Counties, Tennessee	Tennessee Valley Authority	2001	10,680	10,560	495	21.3	10	*Rural Developed*. Located between Nashville and Chattanooga, TN, near Highways 41A and 64. The lake has 275 miles of shoreline. Approximately 62.5% of the shoreline is protected from development, ensuring the lake will not be overdeveloped. Higher than average percent of total watercraft on the lake are PWC (20% versus national average of 10 to 15%). Fewer than 1% of all boats are canoes/kayaks and sailboats. There are 8 public boat ramps, 2 marinas, 22 miles of bike trails, 6.5 miles of hiking trails, and a golf course on a peninsula in the middle of the lake.
Lake Wawasee	Syracuse, Indiana	Wawasee Area Conservancy Foundation	2007	3,410	2,960	232	12.75	18–22	*Suburban*. Located southeast of Syracuse, IN, next to Indiana State Road 13, between Fort Wayne and South Bend, IN. Largest lake in Indiana, with 36.5 miles of shoreline. Ratio of slow- to fast-moving boats of 1.7:1 during the weekdays and 2:1 during the weekends and holidays. Over 20% of watercraft at peak use times are PWC. Highly developed shoreline with only a few public boat ramps and limited public parking.
Syracuse Lake	Syracuse, Indiana	Wawasee Area Conservancy Foundation	2007	414	311	26	11.96	13–22	*Suburban*. Located directly east of Syracuse, IN, by Indiana State Road 13, between Fort Wayne and South Bend, IN. Ratio of slow- to fast-moving boats of 6:1 on the weekdays and 2:1 on a typical weekend or holiday. Typically used for slow-moving recreation (e.g., fishing). Highly developed shoreline with only one public boat ramp and limited public parking.

Table 4-1. Summary of Carrying Capacity Ranges from Recent Studies (continued)

Lake Name	Location	Operator	Year	Lake Acres	Usable Acres	Peak Boat Count	Calculated Peak Density (acres/boat)	Recommended Density (acres/boat)	Lake Description
Table Rock Lake	Stone/ Taney Counties, Missouri	USACE	2009	43,100	N/A	2,885	14.94	10	*Suburban*. Large lake located just outside Branson, MO. Several major roads cross over or next to the lake, which allows for over 5 million visitors annually. Contains 745 miles of shoreline, 106 resort leases, 203 recreational areas, 107 picnic sites, 1,242 camping sites, 14 marina concessions, 1,800 boat docks, and 140 boat ramps. Wide variety of activities occur on and around the lake.
Lake George	Warren/ Essex Counties, New York	Lake George Park Commission	2015	28,524	25,389	913	28	13	*Suburban*. Located 62 miles north of Albany, NY, at the southeast base of the Adirondack Mountains, just off I-87. About 40% of boat traffic is from private properties, 40% from rentals, and 20% from public boat launch facilities. The southern zone occasionally operates at or above the recommended boat density level while the middle and north zones operate below the recommended density during peak use. Accidents average 17 per year. High level of law enforcement and management planning/involvement keep the lake in pristine condition.
White Bear Lake	Ramsey/ Washington Counties, Minnesota	White Bear Lake Conservation District	2005	2,420	N/A	177	13.67	15	*Urban/Suburban*. Just outside of Minneapolis/St. Paul, MN, on Highway 61. Mostly powerboats, followed by fishing, pontoon, and sailboats. PWC make up about 5% of total watercraft. An even mix of lakefront docks and marina slips, with three public boat launch ramps. Lakewide 30 mph speed limit. Numerous other lakes close by, but White Bear Lake is the largest in the Twin Cities area.

Table 4-2. Summary of Published Optimum Boating Densities

Source	Use/Type of Watercraft	Suggested Density
Ashton (1971)	All combined uses	5–11 acres/boat
Kusler (1972)	Waterskiing only All other uses	40 acres/boat 15–20 acres/boat
Jaakson et al. (1989)	Waterskiing and motorboating Fishing Sailing, kayaking, canoeing All uses combined	20 acres/boat 10 acres/boat 8 acres/boat 10 acres/boat
Warren and Rea (1989)	Motorboats Fishing boats Sailboats Canoes/Kayaks Waterskiing	9 acres/boat 1.3 acres/boat 4.3 acres/boat 1.3 acres/boat 12 acres/boat
Wagner (1991)	All boating activities	25 acres/boat
Warbach et al. (1994)	All motorized uses	30 acres/boat
National Recreation and Park Association	All boating activities	4 acres/boat
Bureau of Outdoor Recreation	All boating activities	9 acres/boat
Arizona Outdoor Recreation Coordination Commission	All boating activities	10–20 acres/boat
Wisconsin Comprehensive Plan	All boating activities	20–40 acres/boat
Louisiana Parks and Recreation Commission	All boating activities	20–40 acres/boat
Olvany and Pitchford (2010)	All boating activities	15–20 acres/boat

4.2 WALROS Results for Raystown Lake

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 4-3** provides an overview of the physical, social, and management attributes used to differentiate the six WALROS classes.

Table 4-3. Attributes Used to Differentiate WALROS Classes

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

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 differ 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 Raystown Lake study zones shown in **Figure 2-1** of Section 2. The team of experts used to inventory these sites consisted of eight Raystown Lake Project Office Rangers (herein referred to as *USACE experts*). The USACE experts were selected based on their extensive knowledge and experience with the recreation uses, incidents, and the setting of Raystown Lake. 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 B.
- 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 B.
- 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 B.

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. Ultimately, CDM Smith experts reviewed and finalized all assessment and determined the lake classification.

Results indicate some variation in the inventory for each study zone, with classifications generally falling between *Suburban* and *Rural Developed*, depending on specific questions and attribute class. 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. The central portions of the lake, specifically Zones 2, 3, and 4, were found to fall within the *Suburban* classification while the northernmost zone (Zone 1) and southernmost zone (Zone 5) were found to fall under the *Rural Developed* classification. Zones 2 and 4 are classified as having the most development, visitor presence and concentration, and recreational diversity. This is due to the two marinas located within these zones. Zone 5 is classified as having the least development and falls the furthest under the *Rural Developed* classification due to its narrow setting; absence of management structures; and greater

distances to recreation facilities, visitors' services, and community settings. The *Rural Development* classification of the lake for Zones 1 and 5 are heavily influenced by the topography of the lake and the extent of the government take line. As WALROS is utilized to ensure visitors realize a particular type of experience, it includes guidelines for recommended boating coefficients, or boating capacity ranges, which correlate with each classification. The reasonable capacity coefficients that correlate with the classifications determined for Raystown Lake are 20 to 50 usable surface acres per boat for Rural Developed areas and 10 to 20 usable surface acres per boat for Suburban areas.

While boating on Raystown Lake, very limited development is visible along the steep shoreline. However, the characteristics of the users, boating experience, and setting just outside of the lake should be considered. Many users of the lake are traveling from urban and suburban areas from across the state and are likely to tolerate more dense boating experiences. Thus, a single classification of *Suburban* is recommended for Raystown Lake. Overall, an appropriate WALROS classification for all study zones at Raystown Lake is *Suburban*, which has an associated broad boating capacity range of 10 to 20 usable surface acres per boat. The lower end of the recommended range is 10 usable acres per boat and should be considered the minimum optimal density for Raystown Lake.

4.3 Social Carrying Capacity at Raystown Lake

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. 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 Raystown Lake. The purpose of the survey was to gather information on user experiences, perceptions, and preferences when it comes to crowding and boating safety at Raystown Lake. This section provides key results from the survey on social perceptions and preferences for safety and crowding. Appendix A provides details on the development, administration, and full results of all questions asked during the boater survey.

4.3.1 Safety

When asked if they agree with the statement *boating conditions on the lake are generally safe,* 67 percent of boaters at Raystown Lake agreed to strongly agreed with the statement. Twenty-six percent of boaters indicated that there is generally an unsafe number of boats on the water. Those boaters living near the lake are much more likely to indicate there is an unsafe number of boats on the water.

Seventy-three percent of boaters indicated that there are no locations on the lake where they feel unsafe, with the remaining 27 percent noting there are locations of concern for boating safety. Those who felt unsafe were further asked their reasons for feeling unsafe, and responses are summarized in **Figure 4-1**. The top reasons for concern were crowding or heavy boat traffic (32 percent) and speed or driving behavior of other boats (30 percent). Additional top concerns included rough or choppy water, narrow or shallow locations, debris, and large size of boats.

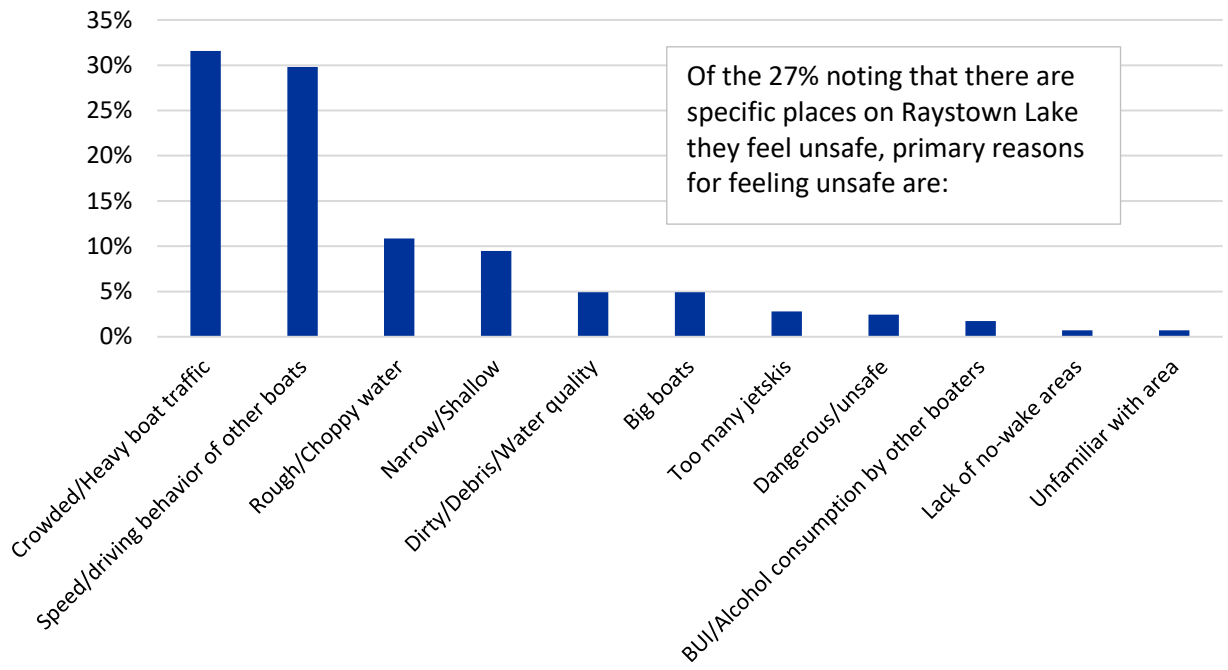

Figure 4-1. Respondents Reasons for Feeling Unsafe at Particular Locations

Respondents also indicated mile markers of the locations in which they felt unsafe. The top response was the area between mile markers 7 and 9, with approximately 30 percent of respondents (of those who indicated they feel unsafe). This area includes Seven Points Marina and Seven Points Boat Launch. The area with the second highest number of responses was the area between mile markers 18 and 21, with 18 percent of respondents (of those who indicated they feel unsafe). This area includes Lake Raystown Resort and Tatman Run and Shy Beaver boat launches.

Most respondents indicated feeling moderately or extremely safe at boat ramps, on the water, and at marinas. While thirteen percent of respondents reported feeling only “somewhat safe” on the water, the clear majority reported feeling moderately or extremely safe, at 45 and 38 percent, respectively. Less than two percent reported feeling “not at all safe”. Additionally, nearly 80 percent of respondents indicated that they feel the speed used by other boaters is generally safe.

4.3.2 Perceptions of Crowding

Answers varied to the question, “How much of a problem is there from too many boats on the lake?”. Eighteen percent of respondents indicated it is not a problem at all, and an additional 18 percent responded that it is a big problem. Thirty-one percent indicated that it is a small problem, and 33 percent indicated that it is a moderate problem. In total, more than half of boaters indicated that there is a moderate to big problem from the too many boats on Raystown Lake.

Respondents’ feelings on crowding at boat ramps, on the water, and at the marina varied. The highest reported feelings of crowding were associated with areas around boat ramps, with 21 percent of respondents indicating feeling extremely crowded and 29 percent feeling moderately crowded. Only 6

percent reported feeling not at all crowded. On the water, 38 percent of respondents reported feeling moderately crowded, and an additional 30 percent felt somewhat crowded. The remaining responses were fairly evenly split between feeling not at all crowded and feeling extremely crowded. At marinas, responses were fairly evenly distributed between feeling not at all crowded, somewhat crowded, and moderately crowded. Only 8 percent of respondents reported feeling extremely crowded at marinas.

Noise was said to reduce boating enjoyment for approximately half of all respondents, with 11 percent indicating that it has significantly reduced enjoyment. When asked to recall their last boating outing, respondents generally indicated that they saw as many boats as they expected to see (69 percent) and about as many boats as they wanted to see (68 percent).

4.3.3 Crowding Threshold

To further gage expectations of crowding, simulated photos of boating conditions on Raystown Lake were provided. 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 Raystown Lake without thinking it was crowded. The photos provided within the survey are shown in **Figure 4-2**. The total acreage depicted within the photo is approximately 100 acres, which allows boat densities to be calculated for each photo. **Table 4-4** provides the acreages depicted in each photo, acres per boat, and the survey response statistics. To better understand the interpretation of this question and its results, if a survey respondent indicated Photo B as their choice for the boating conditions before it is crowded, then they do not feel crowded at the conditions depicted in Photo A but do feel crowded in the conditions depicted in Photos C-E. Thus, the cumulative percentage of respondents was calculated and assumed at each density condition depicted. The proper interpretation of the results using Photo B responses as an example is:

Seventy-one percent of boaters indicate that a boating density beyond 12.5 acres per boat is crowded. In this sentence "beyond" means less acres per boat than 12.5.

Table 4-4. Photo Simulation Acres Per Boat with Tabular Results

Which photo shows the maximum number of boats a respondent could see at one time on Raystown Lake without thinking it was crowded?					
Photo	Acres	Number of Boats	Acres/Boat (darker is more dense boating)	Number Survey Respondents that Selected Option	*Cumulative Percent of Respondents that Indicated Crowded at Density Level
A	100	5	20.0	256	38%
B	100	8	12.5	221	71%
C	100	10	10.0	111	88%
D	100	12	8.3	52	95%
E	100	15	6.7	27	99%
Indicate that no photo is too crowded				5	100%

**Note: If a survey respondent selected "B", then Photos C-E are crowded, for example.*

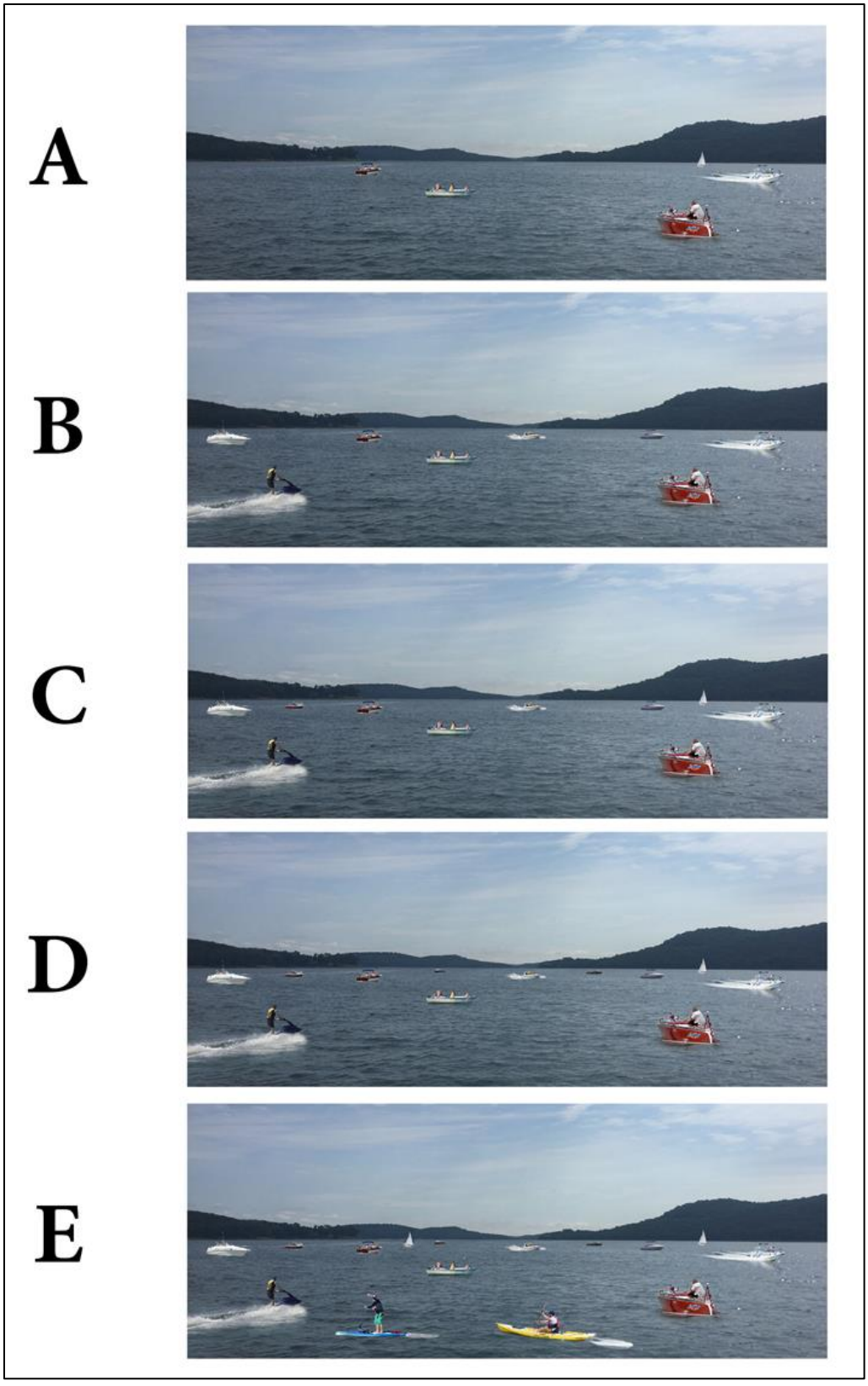

Figure 4-2. Photo Simulation Question Photographs

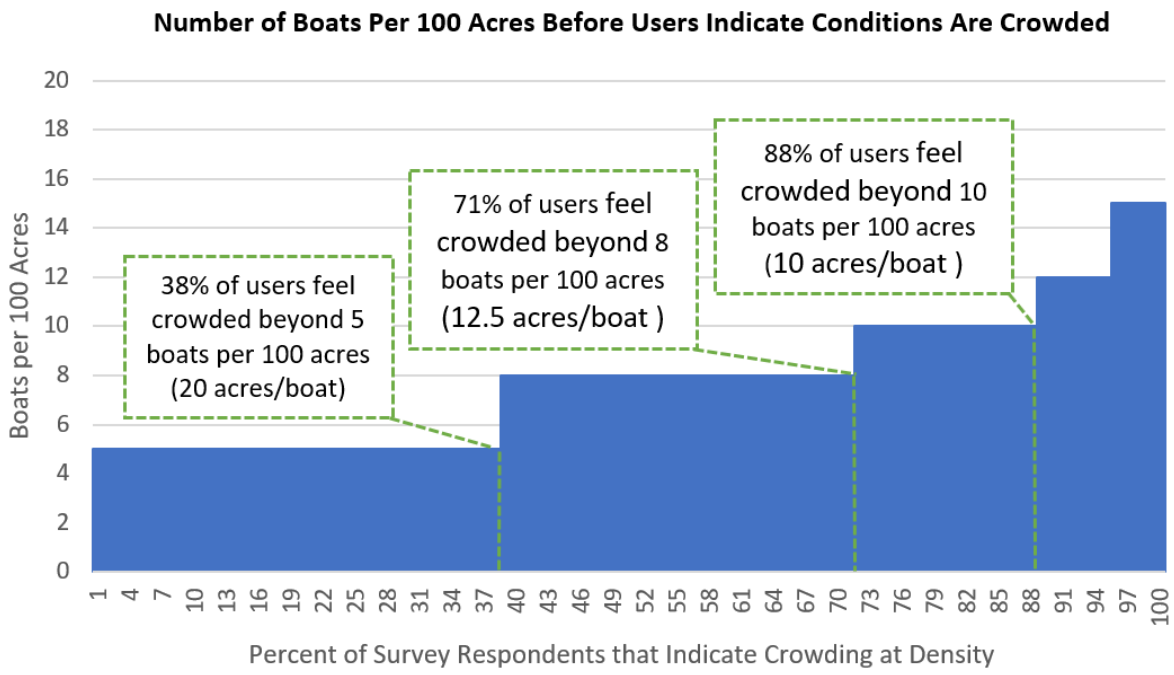

Figure 4-3. Response Identifying Crowding Threshold in Photo Simulation Question

The survey results for the crowding simulation photo are shown in **Figure 4-3**, expressed cumulatively. Nearly 9 out of 10 boaters indicated that a boating density beyond 10 acres per boat is too crowded. Furthermore, 7 out of 10 boaters indicated that a boating density beyond 12.5 acres per boat is too crowded.

4.3.4 Likely Response to Crowding

Respondents were asked how likely they would be to avoid a favorite part of the lake due to the presence of too many boats. Responses were fairly evenly distributed, as shown in **Figure 4-4**. While 22 percent indicated they would be extremely likely to avoid this area, 17 percent indicated they would be not at all likely.

Nearly 55 percent of respondents indicated that they generally stay off the water during parts of the day/week because of too many boats on the lake. An additional 17 percent stated they felt neutral on this topic, with approximately 28 percent in disagreement. Similarly,

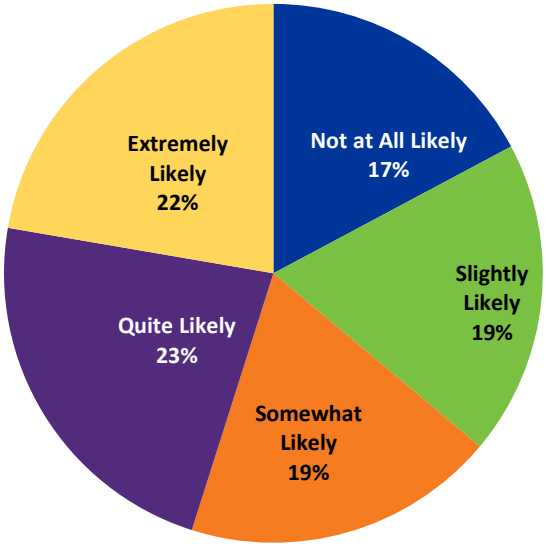

Figure 4-4. Respondents' Likelihood of Avoiding Favorite Parts of Raystown Lake due to the Presence of Too Many Boats

approximately 45 percent of respondents indicated they do not participate in some boating activities due to crowding conditions. Sixteen percent of respondents felt neutral on the subject, and 39 percent disagree with the statement

4.3.5 Displacement

Questions were asked to attempt to measure the extent to which crowding displaces boaters from Raystown Lake. More than half of the boaters at Raystown lake indicated that they generally stay off the lake during part of the day or week because of too many boats on the water. Boaters living near the lake and fishermen are much more likely to avoid the lake during parts of the day or week due to crowding. Nearly half of boaters indicated there are some boating activities they do not participate in due to crowded conditions.

Boaters are likely to avoid some areas due to crowding. Forty-three percent of respondents indicated there are locations on the lake that they deliberately avoid. When asked the reason for avoiding locations, the top response was crowding or heavy boat traffic (37 percent). Additional top responses included narrow or shallow locations, debris, rough or choppy water, and speed or driving behavior of other boats. Results are summarized in **Figure 4-5**.

Respondents also indicated mile markers of the locations that they avoid. As with areas where respondents felt unsafe, the top response to areas that are avoided was the area between mile markers 7 and 9, with approximately 23 percent of respondents (of those who indicated they avoid areas). Similarly, the area with the second highest number of responses was the area between mile markers 18 and 21, with 17 percent of respondents (of those who indicated they avoid areas). Respondents also indicated that they avoid the area between mile markers 25 and 28 (15 percent) and J area (13 percent) (of those who indicated they avoid areas). Each of these later locations are narrow portions of the lake (see Figure 2-3).

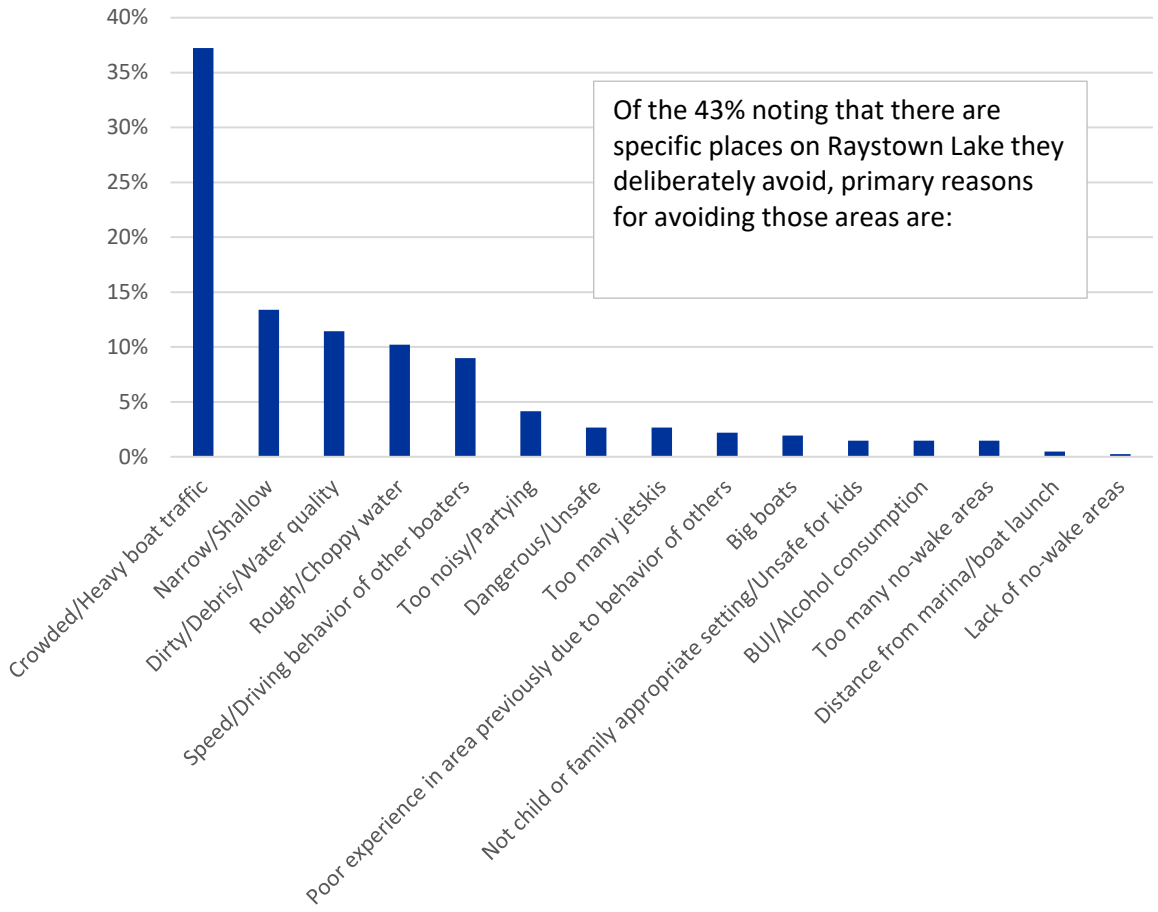

Figure 4-5. Respondents' Reasons for Avoiding Particular Locations

Section 5
Existing Boat Use Study and Results

CDM Smith conducted a field survey to collect data on recreational boating lake use during three high-use summer weekends. Data were collected during this field survey 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 during peak summer boating. 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.

5.1 Field Survey Methodology

The boat use and access study was conducted via field surveys, consisting of coordinated aerial and ground surveys of boats on the water and access area use counts. The aerial team counted boats that were on the water while the ground-based teams counted empty boat trailers at public boat launches, resorts, and campgrounds. Aerial photographs from the helicopter team were used to count rented but empty marina slips. For safety of the field survey team, counts of empty but rented dry slips at Seven Points Marina were provided each week by marina staff. Counts were conducted on three summer Saturday afternoons during the 2018 recreation season.

5.1.1 Aerial Boat Survey

CDM Smith conducted aerial boat surveys over three weekends: June 30 (the Saturday before the Fourth of July), July 7 (the Saturday after the Fourth of July), and August 4. During survey preparations, an alternate survey weekend was scheduled as an alternative for a planned date if an entire weekend was forecasted for rain. **Table 5-1** shows the planned and alternate survey dates. Unfavorable weather conditions prohibited helicopter operations during the weekend of July 21 and likely depressed boater turnout during other periods of that weekend. The study plan held August 11 as an alternate date, but the survey was unable to be conducted due to unfavorable boating weather conditions.

Table 5-1. Primary and Alternate Field Survey Dates

Scheduled Activity	Survey Date	Completion
Primary #1	6/30/2018	Survey Conducted
Primary #2	7/7/2018	Survey Conducted
Primary #3	7/21/2018	Not Conducted
Primary #4	8/4/2018	Survey Conducted
Alternative Date	8/11/2018	Not Conducted

A flyover was completed on each date shown in **Table 5-2** during the peak use times (approximately 1 to 2:30 p.m.). Actual starting and ending times are listed. The direction of travel (north to south or south to north) was varied so that the counts were sampled equally in both directions to eliminate bias in the results. Weather conditions are also listed and were favorable for boating during each flyover; however, there was rain overnight prior to the August 4 flyover, which may have discouraged non-local boaters from traveling to the lake.

Table 5-2. Planned Flyover Direction by Study Zone

Date	Start Time	End Time	Flyover Sequence by Study Zone					Conditions
6/30/2018	12:45 p.m.	2:20 p.m.	1	2	3	4	5	92°F, sunny
7/7/2018	12:45 p.m.	2:05 p.m.	5	4	3	2	1	73°F, sunny
8/4/2018	12:55 p.m.	2:55 p.m.	1	2	3	4	5	82°F, sunny, rain overnight

During each flyover, one observer 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 5-1**).

In coordination with USACE, CDM Smith determined the boating activity/boat types to be recorded. Boats were tallied and recorded as falling into one of the following seven categories:

- Fishing/Bass
- Pontoon
- Houseboat
- Skiing/Wake (pulling passenger)
- Speedboat
- PWC
- Nonpowered (Canoe/Kayak/Paddleboard)

Figure 5-1. Congested Area of Raystown Lake, No-wake Cove, June 30 Flyover

5.1.2 Marina and Boat Ramp Survey

Ground-based field teams surveyed the boat ramps, marinas, and campgrounds around Raystown Lake during the same periods as the helicopter flyovers. In coordination with USACE, CDM Smith identified the public boat launch access points to be surveyed. (**Figure 2-3** shows all boat launch locations at Raystown Lake). The ground teams surveyed all major public recreation areas and the primary public access points to the lake, including all public boat ramps at campgrounds and marinas. **Table 5-3** lists the recreation areas and access points included in the surveys. For reach survey period, the ground teams counted the number of empty boat trailers at each boat launch area and tallied the empty boat slips at both marinas (**Figure 2-3**).

The areas to be surveyed were grouped to allow three two-person ground teams to cover the survey areas within the same 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.

To determine the number of boats on the water from each marina location, CDM Smith tallied the number of rented but empty boat slips at each marina using aerial photographs taken by the helicopter team. Both marinas have a boat ramp; thus, the number of empty boat trailers in boat ramp parking lots was also counted[1]. 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

[1] Seven Points Marina trailer counts were provided by marina staff according to records taken by the front gate staff.

Table 5-3. Raystown Lake Recreation Facilities Included in Field Survey

Location	Study Zone	Total Slips	Trailer Parking Spaces
Aitch	3	N/A	67
James Creek	3	N/A	148
Lake Raystown Resort	4	650	N/A
Seven Points	2	946	160[1]
Shy Beaver	4	N/A	147
Snyder's Run	1	N/A	83
Tatman Run	4	N/A	59
Weaver Falls	5	N/A	37
Hwy 994 Bridge	4	N/A	N/A
Heritage Cove	5	N/A	N/A

Marina and resort slip counts are based on data sources provided by the Raystown Lake USACE Project Office staff.
[1]Seven Points trailer parking spaces are for the USACE-managed boat launch; the total does not include the parking spaces for the marina boat launch ramps or trailer parking that occurs at the campground.

5.2 Boat Type and Distribution Results

CDM Smith tallied 3,999 boats during the completed aerial boat count survey periods. Of all the boats counted, 94 percent were motorized, and 6 percent were nonmotorized vessels (canoes/kayaks/paddleboards). The most popular type of boat was speedboats (44 percent), followed by pontoons (26 percent), PWCs (13 percent), nonmotorized (6 percent), boats pulling water-skiers (4 percent), houseboats (4 percent), and fishing boats (3 percent). **Figure 5-2** shows the total number of observed boats by type. The boat types tallied on the water during peak boating times closely compare to the boat types reported in the boating survey with a few exceptions. The boating survey reported 34 percent ski, wake, or speed boats; 33 percent pontoons; 12 percent fishing boats; 4 percent houseboats; and 2 percent PWCs. The differences between survey responses and aerial counts during peak boating are likely attributable to crowding and time of day preferences. Fishing boats are not as likely to engage in boating activities during mid-day peak boating, whereas PWCs are more likely to be active during that time.

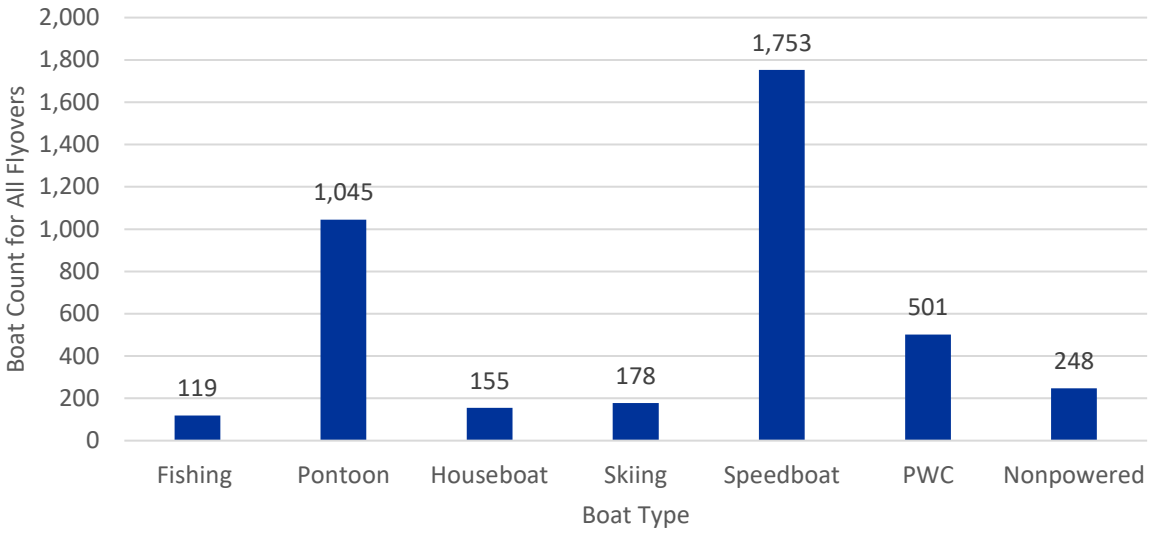

Figure 5-2. Total Number of Boats for All Flyovers by Type

Total boat counts ranged from 1,182 to 1,414, with the weekends before and after the Fourth of July having counts higher than the August count. The highest overall number of boats counted during any survey period was on the afternoon of June 30, 2018, when 1,414 boats were observed on the lake. Zone 3 was observed as having the highest boat count during the June 30 flyover, which was also the highest boat count per zone for the entire study period. The boat counts by survey period and study zone are included in **Table 5-4**.

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

Date	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
6/30/2018	**330**	345	**397**	282	60	**1,414**
7/7/2018	329	349	339	**302**	**84**	1,403
8/4/2018	281	**352**	262	261	26	1,182

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

Overall, for the three survey periods, Zone 2 tallied the highest number of boats, with 1,046, followed by Zone 3 with 998. Zones 1 through 4 each totaled between 21 and 26 percent of the total number of boats. A significantly fewer number of boats was observed in Zone 5 (4 percent). Total boat counts and the percent of total boats by study zone are shown in **Figure 5-3.**

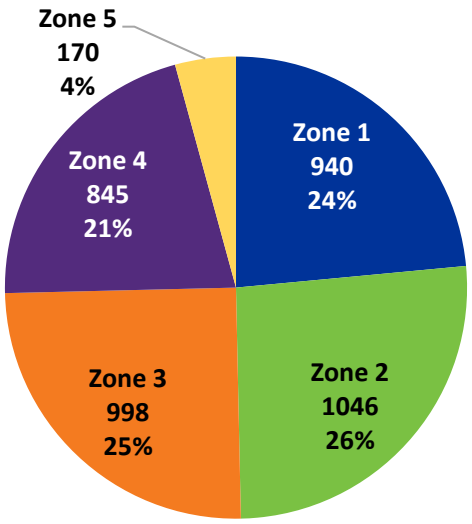

Figure 5-3. Count of Total Boats Surveyed by Study Zone

The type of vessel and associated recreational activity varied between study zone. Speedboats were the most common type of boat observed in all study zones. In Zones 4 and 5, 22 percent of the boats were PWC, which is higher than the other study zones; houseboats were more likely to be found in Zones 1 to 3 (**Table 5-5**). **Figure 5-4** displays the average boat type by study zone.

Table 5-5. Distribution of Boat Type within Study Zones

Study Zone	Fishing	Pontoon	Houseboat	Skiing	Speedboat	PWC	Non-powered
Zone 1	2%	24%	5%	5%	52%	8%	5%
Zone 2	3%	31%	4%	6%	37%	11%	8%
Zone 3	4%	24%	6%	2%	52%	9%	3%
Zone 4	3%	23%	>1%	4%	36%	22%	10%
Zone 5	4%	29%	2%	7%	34%	22%	2%
Lake-wide Average	**3%**	**26%**	**4%**	**4%**	**44%**	**13%**	**6%**

Note: Totals for the study zones do not always sum to 100% due to rounding errors.

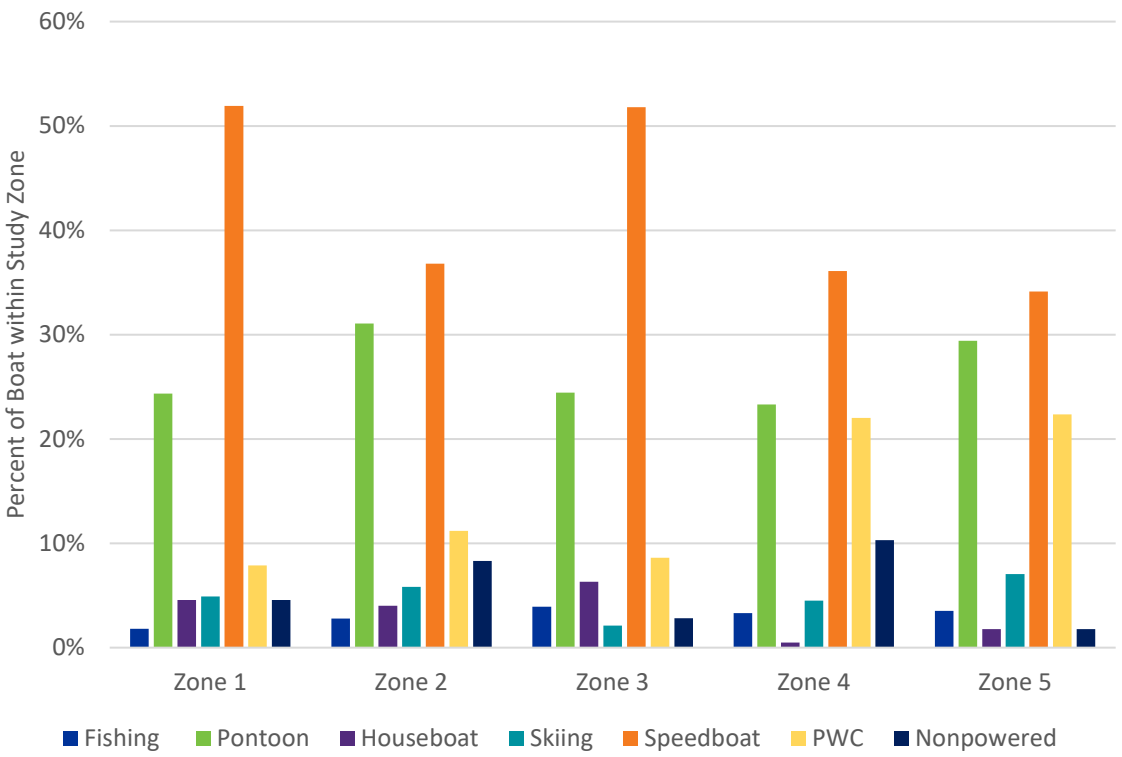

Figure 5-4. Boat Type by Study Zone

An alternative way to view the data is to consider how each boat type is distributed across the lake, which more clearly shows where boat types are utilized in one or two lake zones over others. **Table 5-6** and **Figure 5-5** show that of all the fishing boats, the greatest number was found in Zone 3 at 33 percent. The greatest number of pontoon boats were found in Zone 2. Houseboats were found most often in Zone 3. Skiers utilized Zone 2 most often. Speedboats utilized Zones 1 and 2. Zone 4 was most popular for PWC users. Nonpowered boats such as canoes, kayaks, and paddleboards utilized Zones 2 and 4.

Table 5-6. Distribution of Each Boat Type by Study Zone

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Fishing	14%	24%	33%	24%	5%
Pontoon	22%	31%	23%	19%	5%
Houseboat	28%	27%	41%	3%	2%
Skiing	26%	34%	12%	21%	7%
Speedboat	28%	22%	29%	17%	3%
PWC	15%	23%	17%	37%	8%
Nonpowered	17%	35%	11%	35%	1%
All Boats	**24%**	**26%**	**25%**	**21%**	**4%**

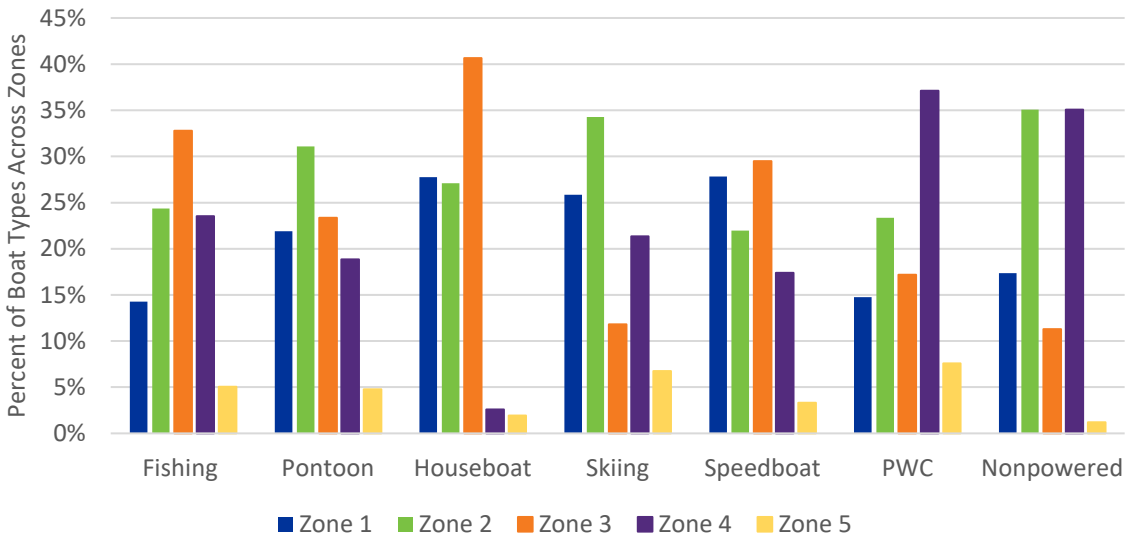

Figure 5-5. Boat Type Distribution across Study Zones Weighted for Zone Area

5.3 Observed Peak Boat Density

The observed peak boating density for Raystown Lake is calculated by dividing the usable water surface acres by the boat count from the survey period that tallied the highest number of boats (June 30):

Observed Peak Density = 7,995 acres ÷ 1,414 boats = 5.7 usable acres per boat

Table 5-7 shows the observed peak density by zone from the collected field data. For Zones 1 and 3, CDM Smith observed the highest number of boats during the June 30 flyover. For Zones 4 and 5, the highest boat density was observed on July 7. For Zone 2, the highest number of boats was observed on August 4. Zone 3 had the greatest density of boats at 3.6 usable acres per boat, followed by Zone 4 at 5 usable acres per boat.

Table 5-7. Observed Peak Boat Density by Study Zone

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Usable Acres	1,773	2,803	1,430	1,519	469
Maximum Number of Observed Boats	330	352	397	302	84
Usable Acres per Boat	5.4	8.0	3.6	5.0	5.6
Observation Date	6/30/18	8/4/18	6/30/18	7/7/18	7/7/18

5.3 Boat Origination Results

Boaters can access Raystown Lake from various infrastructure and facilities: public boat launch ramps, marina slips or ramps, or resort docks. In general, 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.

5.3.1 Public Access Ramp Results

USACE-Managed Ramp Results

According to data provided by USACE, there are 701 boat trailer parking spaces located in recreation areas managed by USACE (**Table 5-8**). This represents appropriately sized parking spaces that accommodate trailer parking at USACE facilities. Parking spaces are first come, first serve, and there is no signage or laws preventing a vehicle without a trailer from parking in those spaces. Additionally, double parking was observed at several locations. These factors can lead to parking lots that are considered full even if the maximum number of trailers is not present.

Table 5-8. Available Trailer Parking Spaces at USACE-Managed Areas

	Study Zone	Empty Boat Trailers 6/30/18	Empty Boat Trailers 7/7/18	Empty Boat Trailers 8/4/18
Snyder's Run	1	81	85	85
Seven Points Ramp and Overflow	2	137	138	111
James Creek	3	110	113	99
Aitch	3	64	54	50
Shy Beaver	4	103	104	73
Tatman Run	4	62	63	45
Weaver Falls	5	44	40	32
Total		601	597	495

Note: Only USACE-managed parking areas are included in this count.

CDM Smith tallied a maximum day count of 601 empty trailers on June 30 on USACE-managed launch and overflow parking lots. Overall, USACE lots were at 86 percent of trailer capacity during the June 30 survey. Parking within lake Zone 1 was often at or above maximum capacity; additionally, this zone has a privately- owned parking area adjacent to a boat launch area where additional boat trailers were parked. Lake Zone 2 was consistently under capacity on all the survey dates, with a utilization of approximately 86 percent. Overflow parking areas are the primary reason for this low utilization rate as those areas are less conveniently located compared to the launch area parking. Lake Zone 3 and lake Zone 4 were each at 81 percent capacity on the maximum usage day during the field surveys; these zones also had the highest numbers of parking spaces available. Lake Zone 5 exceeded capacity two out of the three field survey days, with boat capacities of 108 percent on July 7 and 118 percent on June 30. Capacity exceedances were generally the result of parking in unassigned spaces. Despite trailer counts at less than capacity, USACE staff reported all launch parking spots full by 10:30 a.m. during the June 30 count and by 11:30 a.m. on the July 7 count. Full capacity is reached due to single vehicles parking in trailer parking spaces and, in some cases, vehicles double parking. Parking spaces, including trailer parking, are available on a first come, first served basis for all vehicle types because visitors may be participating in recreational activities on the lake without being in a boat. Examples of these activities include hiking and shoreline fishing. Additionally, boater capacity often exceeds vehicle capacity, leading additional occupants to arrive in a separate vehicle, not towing a boat.

Campgrounds, Outgranted Areas, and Private Parking/Ramp Results

Trailer counts were tallied for Seven Points Campground and parking areas outgranted to private entities, including Seven Points Marina and Lake Raystown Resort. Additionally, trailers were counted along Highway 994 bridge, at Heritage Cove Resort, and in private lots adjacent to USACE-managed launch ramps (visible from USACE property). Trailer counts were not collected at additional USACE-managed campgrounds because they are not located close enough to a boat ramp or launch facility. As these locations do not have dedicated parking for boat trailers, the total available trailer parking spaces are not estimated. Therefore, the percent of capacity utilized during peak boating is not calculated for these facilities. A maximum of 332 trailers was counted at outgranted, campground, and private lots during the July 7 survey period (**Table 5-9**).

Table 5-9. Total Number of Empty Boat Trailers at Outgranted and Private Lots

	Study Zone	Empty Boat Trailers June 30	Empty Boat Trailers July 7	Empty Boat Trailers August 4
Snyder's Run Private Parking	1	12	19	5
Seven Points Campground	2	35	45	24
Seven Points Marina	2	43	38	35
Lake Raystown Resort	4	174	194	151
Hwy 994 Bridge	4	3	1	0
Heritage Cove	5	33	35	1
Total		300	332	216

Total Trailer Parking Results

Including parking areas that are managed by USACE and outgranted to private entities, 929 empty boat trailers were tallied during the July 7 survey. Results are provided by major facility type in **Table 5-10**, and by study zone in **Table 5-11**. The count of empty boat trailers by study zone is shown in **Figure 5-6**.

Table 5-10. Total Number of Empty Boat Trailers from All Access Areas

	Empty Boat Trailers June 30	Empty Boat Trailers July 7	Empty Boat Trailers August 4
USACE-Managed Boat Ramps	601	597	495
Campgrounds, Outgranted Areas, Private Parking	300	332	216
Total	901	929	711

Table 5-11. Total Number of Empty Boat Trailers from All Access Areas by Study Zone

Date	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
6/30/18	93	215	174	342	77	901
7/7/18	104	221	167	362	75	929
8/4/18	90	170	149	269	33	711

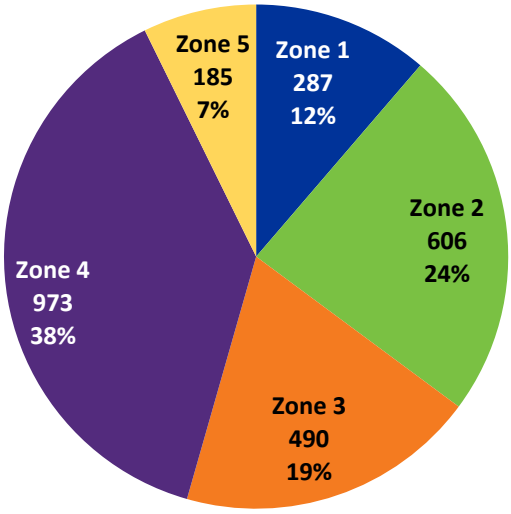

Figure 5-6. Empty Boat Trailers by Study Zone
Note: Includes both USACE-managed parking areas and outgranted parking areas, including but not limited to Seven Points Marina, Lake Raystown Resort, and Heritage Cove.

5.3.2 Marina Slip Survey Results

According to USACE data, there are two commercial concession marinas located on Raystown Lake that have a total of 1,596 slips. The overall occupancy rate for all marinas at the time the marina surveys were conducted was 99.7 percent. **Table 5-12** identifies usage information for each marina at the time of the survey. CDM Smith obtained slip rental information from each marina operator at the time of the field surveys. There are no marinas located in Zones 1, 3, or 5.

Table 5-12. Marina Slip Information

Marina	Study Zone	Total Slips[1]	Slips Rented[2]	Percent Rented
Seven Points Marina	2	946	936 to 945	98.9 to 99.9%
Lake Raystown Resort Marina	4	650	650	100%
Total		1,596	1,586 to 1,595	99.4 to 99.9%

[1]*The total number of slips is based on data provided by the USACE Project Office staff.*
[2]*Range from all the field surveys.*

Data from each of the survey periods are summarized in **Table 5-13**. The highest number of boats on the water, counted as empty but rented slips, occurred during the June 30 survey, with 584 boats on the water from both marinas, accounting for 37 percent of total marina capacity.

Table 5-13. Boats Originating from Marinas by Survey Period

	Seven Points Marina		Lake Raystown Resort			
Date	Empty Slips	% of Total Slips	Empty Slips	% of Total Slips	Total	% of Boats on the Water
6/30/2018	309	33%	275	42%	584	37%
7/7/2018	340	36%	223	34%	563	35%
8/4/2018	254	27%	211	32%	465	29%

5.3.3 Boat Origination Summary

Data are summarized to provide the average peak day boat origination percent for USACE-managed boat ramps, marina slips, and campgrounds; private parking/ramps; and outgranted parking areas. A maximum of 1,492 total empty marina slips and boat trailers were counted on July 7 (**Table 5-14**). This number exceeds the 1,403 boats on the water counted by 89. These anomalies in the data are expected because boats are moving on and off the water during the time it takes to complete the counts, some marina slips may be rented but empty on the day of the count (in cases of boats off the water due to maintenance, etc.), and some boat trailers parked at the marinas and campgrounds may be associated with a nonpermanent slip rental, for examples. Assuming the margin of error is equally distributed across the facilities, percentages are calculated to understand what proportion of boats on the water during peak boating times are accessing the lake from the various facilities. During peak boating periods, approximately 41 percent of the boats on the water during the survey periods came from the USACE-managed boat ramps, 39 percent from marina slips, and 20 percent from campgrounds, private parking/ramps, and outgranted parking areas. **Figure 5-7** displays the average boat origination summary by facility type.

Table 5-14. Summary of Boat Origination Results

	June 30	July 7	August 4
Empty Marina Slips	584	563	465
Empty Trailers at USACE-Managed Boat Ramps	601	597	495
Empty Trailers at Campgrounds/Private/Outgranted Lots	300	332	216
Total	1,485	1,492	1,176

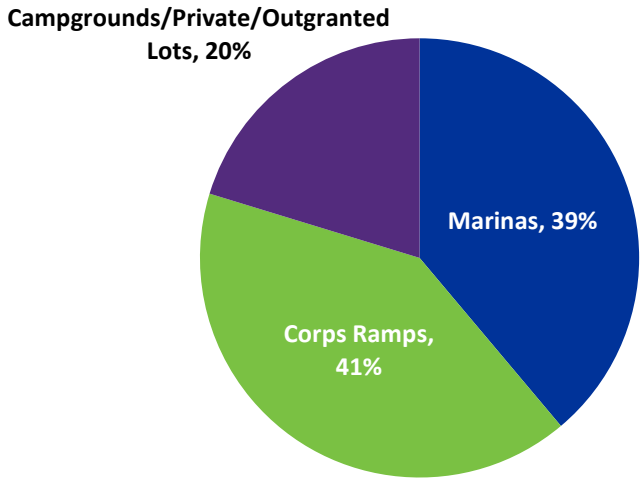

Figure 5-7. Average Boat Origination by Facility Type

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Section 6

Boating Capacity Analysis and Study Conclusions

6.1 Boat Density Analysis

As discussed in Section 5.3, the maximum observed peak density lakewide during a single day was 5.7 usable acres per boat. This calculation can be further evaluated by study zone to determine if the overall lake capacity metric varies by zone. **Table 6-1** shows the calculations of maximum observed boats and current boat densities by study zone. Zone 3 has the greatest density of boats during peak. With a recommended maximum density from the WALROS analysis (Section 4.2), results indicate that all zones have exceeded its recommended carrying capacity.

Table 6-1. Observed Boat Densities by Study Zone

Study Zone	Usable Acres	Max Observed Boats	Current Boat Density (usable acres/boat)	Recommended Maximum Boat Density (usable acres/boat)	Analysis of Capacity Utilized
Zone 1	1,773	330	5.4	10	Exceeded
Zone 2	2,803	352	8.0	10	Exceeded
Zone 3	1,430	397	3.6	10	Exceeded
Zone 4	1,519	302	5.0	10	Exceeded
Zone 5	469	84	5.6	10	Exceeded
Lake-wide	7,994	1,414	5.7	10	Exceeded

6.2 Total Boat Capacity and Facility Use Rates

Boaters can access Raystown Lake from various infrastructure and facilities: public boat ramps, marina slips, or marina boat ramps. 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 Raystown 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, 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. Data were not available to determine the total available trailer parking at outgranted or private parking areas nor campgrounds; therefore, these are not included as available access points. Thus, available access opportunities for boat trailer parking only include the USACE-managed public boat ramp parking spaces. The *Total Access Opportunities* for Raystown Lake is 2,297 boats and was calculated as follows:

701	Boat trailer parking spaces at USACE-managed boat ramps (**Table 2-4**)
+ 1,596	Marina slips (**Table 2-3**)
= 2,297	Total Access Opportunities

Facility Use Rate is a measure of the estimated number of boats on the lake at peak times from the access points. *Facility Use Rate* is calculated by dividing the *Total Access Opportunities* by boats originating from these access points. Thus, boats originating from outgranted ramps or private parking areas are not included in the calculations for facility use rates. Currently, the *Facility Use Rate* for Raystown Lake during peak boating is 47 percent and is calculated as follows:

Facility Use Rate = [(*Total Boats on the Water – Boats Originating from Private/Outgranted Facilities) ÷ Total Access Opportunities*] * 100
= [(1,414 – 332) ÷ 2,297] * 100 = 47 percent

Therefore, during peak use periods, one can reasonably expect that 47 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 the number of boats on the water:

Facility Impact Rate = 100 ÷ Facility Use Rate = 2:1

The *Facility Impact Rate* can be interpreted as follows: *At Raystown Lake, adding two access opportunities results in one additional boat on the water during peak times.* The *Facility Impact Rate* is a measure of the proportion of available access infrastructure to boats on the water at one time. It can be a useful tool to estimate the effects of changes in *Total Access Opportunities* on boats on the water at one time. 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 USACE-managed public boat ramp facilities have the highest impact on total boats on the water at one time, with an impact ratio of 1:1, followed by marinas with a ratio of 3:1. The additional boats that are accessing the lake during peak boating times are utilizing trailer parking available at the marinas, campgrounds, outgranted areas, and other private parking areas. During peak boating, approximately 20 percent of boats currently originate from campgrounds, outgranted areas, and private parking areas. This equates to approximately 300 boats on the water.

- **Marinas**
  - *Marina Facility Use Rate* = [584 empty but rented slips ÷ 1,596 total available slips] * 100 = 37 percent
  - *Marina Facility Impact Rate* = 100 ÷ 37 = 3:1
- **USACE-Managed Boat Ramps in Public Recreation Areas**
  - *USACE-Managed Boat Ramp Facility Use Rate* = [601 empty boat trailers ÷ 701 boat trailer parking spaces] * 100 = 86 percent
  - *USACE-Managed Boat Ramp Facility Impact Rate* = 100 ÷ 86 = 1:1

6.3 Changes in Boating Since the 1988 Study

Section 3.3 summarizes the key results of the boating study conducted at Raystown Lake in 1988. It is useful to compare boating conditions, facility uses, and boater perceptions as recorded in that study to the current conditions characterized in this study to assess any major changes in boating conditions over the past 30 years. **Table 6-2** presents a summary of key data from the 1988 and current study. As shown, more than 300 additional boats were found to be boating during peak summer use, an increase of 28 percent. This translates to an overall greater boat density. Note that while there are many similarities between the 1988 study and the current study, there are also a few differences in methodology and results worthy of noting. The most notable difference in methodology is the usable acreage calculation. In the 1988 study, there was no buffer area removed from the lake surface area to account for restricted areas when calculating the total usable surface acreage. The study presented herein removed restricted areas from the usable lake surface area, as described in Section 2.2. Had restricted and usable areas been removed from the 1988 study calculations, the boat density would have been a greater density.

Table 6-2. Comparison of Current Study with 1988 Boating Study

Description	1988 Study	2018 Study
Usable Lake Surface	8,500 Acres	7,994 Acres
Total Marina Slips	1,200	1,596
Total Car/Trailer Spaces	579	701
Greatest Number of Boats Recorded	1,101	1,414
Boating Density Range (Acres per Boat)	10.5 to 7.5 (Avg. 9)	8 to 3.6 (Avg. 5.7)

Over the past 30 years, the number of marina slips and car/trailer parking spaces available at boat ramps has increased, with over 500 additional access opportunities added. While there was a 30 percent increase in access opportunities, a nearly proportional increase in peak boating occurred. Thus, increasing the number of marina slips from 1,200 to 1,596 and increasing the number of car/trailer spaces at boat ramps from 579 to 701 resulted in an average overall boat density change of 9 acres per boat in 1988 to 5.7 acres per boat in 2018.

In terms of the type of boats utilized on Raystown Lake, there were changes from 1988 to 2018. In the 1988 study, pontoon boats made up only 6 percent of total boaters surveyed. This increased to 33 percent of current users. The size of boats has increased over time, with 69 percent of boats measuring greater than 20 feet in 1988 compared to 93 percent in 2018.

Over half of current users reported feeling moderately to extremely crowded on the water, compared to 36 percent of survey respondents in the 1988 study. Perceptions on displacement have significantly increased as well, as shown in **Table 6-3**. In 1988, only 27 percent of survey respondents reported that they stayed off the lake during parts of the day to avoid crowded conditions. Fifty-five percent of current users reported that they avoid certain days of the week or times of day to avoid crowding. Additionally, 45 percent of current users reported avoiding some activities due to crowding compared to 23 percent in 1988. The general perception on the safety of boating conditions has declined by 11

percentage points. On the questions that can be directly comparable that are shown in **Table 6-3**, boaters report more displacement and perceptions of feeling less safe on all accounts.

Table 6-3. Comparison of User Perceptions in Current Study with 1988 Boating Study

	% Respondents Agree	
	1988 Study	2018 Study
I generally stay off the lake during parts of the day/week because of too many boats on the lake	27%	55%
I generally do not participate in some boating activities because of crowded conditions at the lake	23%	45%
There are generally an unsafe number of boats on the water	17%	26%
Other boats generally come closer to my boat than I like	34%	41%
The behavior of other boaters generally interfered with the quality of my boating experience	22%	33%
Boating conditions on the lake are generally safe	78%	67%

Despite the increase in boating density and perceptions of crowding and displacement, survey respondents in the 2018 study indicated a higher satisfaction rate, with 83 percent indicating the quality of their boating experience was an 8 or higher. This was up from the 1988 study in which 61 percent of respondents indicated the quality of their boating experience was an 8 or higher.

6.4 Study Conclusions

All study results indicate that carrying capacity at Raystown Lake has been reached or exceeded. This study collected comprehensive data regarding boat use levels, facility impacts, crowding, and safety. Numerous boating capacity studies across the nation recommend densities around 12.5 acres per boat, and the WALROS calculation for Raystown recommends a maximum density of 10 acres per boat. The observed density at Raystown Lake peaked at 5.7 acres per boat (single day, lakewide), with Zone 3 having an even higher density of 3.6 acres per boat.

Over the past 30 years, the boating density at Raystown Lake has increased nearly proportional to the additional number of access opportunities added over that period. Over 500 access opportunities have been added, and the peak boating increased by 300 additional boats on the water. The marina occupancy rate is essentially 100 percent. During the summer months, boat ramps exceed capacity approximately 62 percent of the time. With the calculated *Marina Facility Impact Rate* of 3:1 and *USACE-Managed Boat Ramp Facility Impact Rate* of 1:1, along with the historical evidence that confirms the impact of additional access points on peak boating, it is reasonable to assume that future increases in access opportunities will proportionally increase the number of boats utilizing the reservoir during peak boating days and further increase boating density beyond the crowded conditions already experienced.

Data and survey results also indicate that the social carrying capacity has been reached or exceeded. More than two-thirds of surveyed boaters feel somewhat to moderately crowded on the water, and more than half indicated there is a moderate to big problem with too many boats on the water, exceeding the thresholds for social capacity established in literature (ERM, Inc. 2004). Nearly 9 out of 10 boaters indicated that a boating density beyond 10 acres per boat is too crowded. Furthermore, 7

out of 10 boaters indicated that a boating density beyond 12.5 acres per boat is too crowded. This is far less dense than the current peak boating on the lake. Meeting the social preference for 10 acres per boat, which is also aligned with the minimum recommended WALROS density, would equate to a total of 800 boats on the water during peak time. A density of 8 acres per boat, which is less dense than current peaks but more dense than social preferences, would equate to 1,000 boats on the water during peak boating, or 400 less than current peak boating.

Boaters have responded to crowded conditions by avoiding activities, places, and days and times of the week, generally reporting a high level of displacement. Forty-five percent of surveyed boaters indicate they avoid certain activities due to crowding. On the questions that can be directly comparable to the 1988 study of Raystown Lake, boaters report more displacement and perceptions of feeling less safe on all accounts. It is reasonable to associate these changes in user experiences to the increase in boat density over the past 30 years. If boat density further increases, it is likely that positive boating experiences will decrease.

Raystown Lake has, on average, seven boating incidents per year, with two to three caused by crowding. These crowding-related incidents at Raystown Lake resulted in bodily injury 68 percent of the time. A recent study of Beaver Lake in northwestern Arkansas reported a similar per year crowding-related incident rate; however, Beaver Lake has more than three times the usable boating acreage when compared to Raystown Lake (CDM Smith 2017). Beaver Lake was found to have the highest incident rate in its region. Lake George, located north of Albany, experiences what is reported as a high incident rate, with an average of 17 incidents per year (Lake George Park Commission 2016). Lake George is also three times the size of Raystown Lake but has fewer boating incidents per usable acreage. While direct comparisons on incident data are limited, it appears that Raystown Lake has a high rate of boating incidents proportional to its size.

Should peak boating numbers persist, management activities could be implemented to mitigate areas of high congestion with the goal of reducing boater conflicts. Studies indicate that waterskiing requires 12 to 20 acres per boat for safe conditions (Jaakson et al. 1989; Warren and Rea 1989). While few waterskiing boaters were observed during peak boating (making up only 4 percent of the total boaters), it is reasonable to assume that if boating densities continue to peak at 2018 levels, this type of activity should be prevented during peak weekend and holiday boating days to ensure the safety of the boaters. Without management actions to reduce the number of boats on the water, other management actions could be taken to improve safety such as speed limits enforced in areas with high congestion and a significant history of boating incidents. Additionally, many of the crowding-related boating incidents occurred from large wakes created by other boats. Speed limits and boat size constraints could mitigate the occurrence of these incidents.

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Appendix A

Raystown Lake Boating Survey Report

This appendix describes the Raystown Lake Boating survey administered to recreational boaters at Raystown Lake following the 2018 summer boating season. Section A.1 describes development and administration of the survey. Section A.2 provides the survey questionnaire that was administered. Section A.3 presents the basic frequency of response for each question and Section A.4 discusses the survey limitations.

A.1 User Survey Development and Administration

A.1.1 Survey Design and Approval

To avoid overburdening the public with federally sponsored data collections, the Paperwork Reduction Act (PRA) of 1995 requires that U.S. federal government agencies obtain Office of Management and Budget (OMB) approval before requesting or collecting most types of information from the public. In accordance with the PRA, OMB approval must be obtained prior to collecting federally sponsored data in any situation where 10 or more respondents, within a 12-month period, are involved. The questions are standardized in nature whether they are delivered in-person, on the telephone, or online.

The Raystown Lake Boating Survey was submitted to OMB under the Interagency Generic Clearance for Federal Land Management Agencies Collaborative Visitor Feedback Surveys on Recreation and Transportation Related Programs and Systems (OMB control number 0596-0236). The generic clearance was submitted jointly to help the signatory Federal Land Management Agencies, including the Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, Forest Service, and Army Corps of Engineers, improve transportation conditions and recreation and resource management. The FLMA clearance was designed to collect information about visitors' perceptions, experiences, and expectations, with respect to transportation conditions, services, and recreation opportunities at various FLMA locations and across areas that could include multiple locations managed by different FLMAs. OMB approval is still required for each survey requested to be administered under the FLMA clearance.

Survey questions related to these topics have been compiled for use in designing surveys submitted under the FLMA clearance, use of which helps to streamline the approval process. The OMB approval process requires identification of which questions in the proposed survey are taken from the previously compiled questions. Questions that are not in the collection are allowed, but the source for these questions must be clearly identified (e.g., are they new or are they taken from a previous survey that has been approved by OMB), and these questions must be reviewed and approved by OMB.

Pulling from the question collection, 29 questions were selected to determine respondent characteristics, assess visitor experiences, and characterize trip behaviors. Three non-compendium questions were asked from a recently expired OMB Clearance (0710-0001) and three non-

compendium questions were asked from the 1988 Raystown survey (OMB Control # 0702-0016). One of the questions from the 1988 Raystown Survey was modified based on a 2013 Coast Guard survey (OMB Control # 1625-0089). The questions were combined into a survey instrument with an accompanying cover letter. Experts in graphic design and development of publicly distributed materials were involved in designing the cover letter to improve the response rate. The final mail out survey instrument approved by OMB is provided in Section A.2.

Pre-testing and consultation were conducted with six USACE staff members with no specific background or training in survey research methods or analysis (i.e., representative of the public, rather than survey experts). Specifically, the individuals were asked to complete the questionnaire and then asked a series of debriefing questions to elicit their feedback on the practical utility of the study, questionnaire/respondent burden, quality and clarity of the questions and instructions, and ways to minimize respondent burden. Comments were incorporated into the final instrument.

The survey was offered through two mediums: online and paper copy via a mail out/mail back method. The online survey was hosted at surveygizmo.com. The online survey was tested on a variety of operating systems and hand-held, personal devices to ensure those who preferred to take the survey online could access and complete each question. No Personally Identifiable Information was maintained during the survey process.

A.1.2 Photo Simulation Question Development

A question was allowed by OMB that simulates maximum acceptable impact using photo simulation of a scale of watercraft density. This method has been widely used in the parks and recreation assessment field for simulating hiker and vehicular traffic that is acceptable to visitors. The method has been applied in numerous boating capacity studies as well. The photo simulation is effective for collecting evaluative information about use levels that are higher and lower than the current, existing lake use levels. The goal of the photo simulation is to provide a foundation for careful assessment of the reasonable range for social carrying capacity at Raystown Lake.

The survey Question 26 asked respondents: *Which photo shows the maximum number of boaters you could see at one time on Raystown Lake WITHOUT thinking it was too crowded?*

The photo simulation was developed for a previous study and modified for Raystown Lake, as shown in **Figure A-1**. Boats were added to simulate a range of reservoir use levels per **Table A-1**.

Table A-1. Photo Simulation Acres Per Boat

Photo	Acres	Number of Boats	Acres/Boat
A	100	5	20.0
B	100	8	12.5
C	100	10	10.0
D	100	12	8.3
E	100	15	6.7

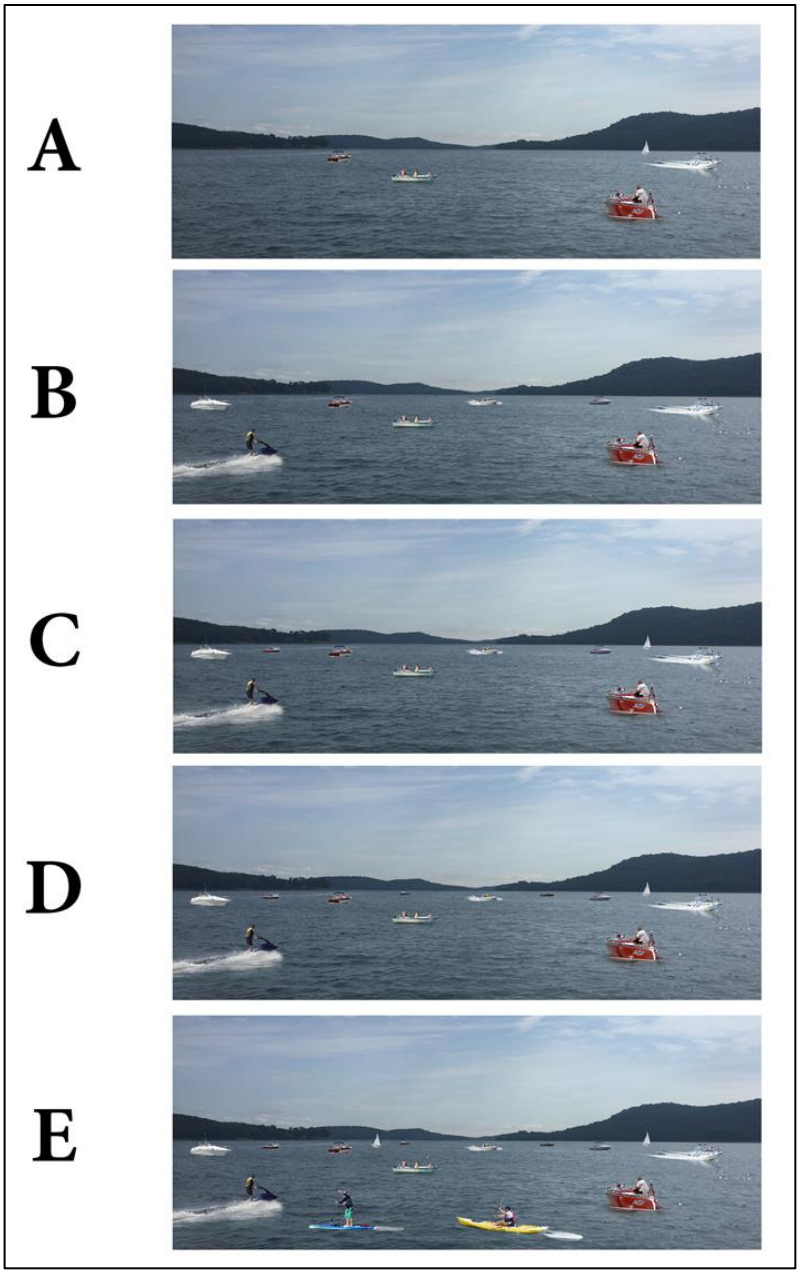


Figure A-1. Resulting Photo Simulation Question Photos A–E

A.1.3 Population Sampling

The procedure for administering the Raystown Lake boater survey followed guidance provided by the Corps. OMB reviewed and approved the survey administration procedures. Because it is not possible to survey every single boater who used the lake in 2018, a *sample* of boaters was selected to receive the survey, and their responses are assumed to be representative of the population. A sample consists of all units of the population that are drawn from for inclusion in the survey. The sample was drawn based on standard statistical methods, as further described below.

The survey ***population*** consists of all the units to which one desires to generalize the survey results. For this survey, the population is boaters on Raystown Lake. A "boater" is defined as an operator of a boat that is placed on the water at Raystown Lake for recreational purposes. An owner could be a single individual, family, or two persons or more who jointly own and operate a boat. The population of boaters at Raystown Lake is estimated from summing the number of marina slip renters and estimated number of boaters who launch from public use facilities such as launch lanes at marinas, parks, campgrounds, and end of road access points. At Raystown Lake, there are approximately 1,600 marina slips available[2]. All of the slips were rented in 2018. Including an estimated population for public launch users, the total boating population that currently recreates on Raystown Lake is estimated at 22,740 boaters per month during the peak season.

Given the estimated population, the completed number of returned surveys (*completed sample*) needed to provide statistically significant results can be calculated given Equation 1.

$$N_s = \frac{(N_p)(p)(1-p)}{(N_p - 1)(\frac{B}{C})^2 + (p)(1-p)}$$

Equation 1

Where: N_s = the completed sample size needed for the desired level of precision
N_p = the size of the population (peak season boaters)
p = the proportion of the population expected to choose 1 of 2 response categories
B = margin of error
C = Z score associated with confidence level (1.96 corresponds to 95 percent)

The required Raystown Lake complete sample size for statistically significant results with a 5 percent margin of error is estimated to be 688 total completed surveys. Since public ramp users make up a larger proportion of the total lake user population compared to marina users, different minimum sample sizes for each subpopulation were necessary. A minimum sample size of 310 survey responses from the marina user subpopulation and a minimum sample size of 378 survey responses from the public ramp user subpopulation would be needed for a 5 percent margin of error with 95 percent confidence in the survey responses.

To determine the estimated response rate for the survey and thus the needed sample to be drawn, the various sources of boater contact information were taken into consideration. The mailing and email address list that makes up the sample frame for the survey was generated from three sources:

- Private mailing lists of marinas
- Boaters who registered to receive Master Plan information
- USACE camper registration database

[2] There are 1,596 slips permitted by USACE at Raystown Lake, but the indoor storage rack at Seven Points Marina has been reconfigured to accommodate larger boats. Therefore, the current number of slips is slightly lower.

The two populations (marina users and public ramp users) were provided the same survey but contacted in different manners. The two marinas operating at Raystown Lake did not wish to provide USACE their mailing lists, but agreed to produce two sets of mailing labels, apply labels with the oversight of USACE staff and drop the survey materials in the mail at specified times. Therefore, a census of all marina slip holders (1,600) was conducted.

USACE provided a database of lake users who were registered through on-site canvassing to receive information regarding Master Plan updates and other information. This database contained 532 boaters. The list was checked for duplicate names and addresses, duplicate addresses with different names, duplicate email addresses, names without an address or email, and names with incomplete addresses and no email. This process resulted in a clean list of 482 potential respondents for the public boat ramps.

To sample more public ramp users, a database of 3,458 campers was provided by USACE. This database was checked for duplicates resulting in list of 3,429 campsite users. The list of campers was sorted alphabetically by first name and numbered 1 through 4 repeatedly. The first 700 campers with the number 4 were drawn from this list. Combined with the 482 individuals contacted through on-site canvassing, there were 1,152 potential respondents from the public ramp user subpopulation. The expected response rate was 33 percent (384 responses).

A.1.4 Survey Administration

Randomly-generated access codes were created prior to survey invitations being sent to the public. These unique access codes allowed respondents to take the survey online and ensure that only one response per individual was counted. Once an access code was used it could not be used again. The access codes also allowed for tracking response rates between the different subpopulations throughout the survey administration period.

The survey was administered on October 30, 2018 and left open for 31 days. Responses received through November 30, 2018 were included in the results. Any survey received in the mail that was postmarked on or after December 1, 2018 was not included in the results. The mail out survey included a postage paid, self-addressed return envelope. The respondents were also provided the online survey web address for those who preferred to complete the survey online. The online survey was automatically closed to further responses at 12 a.m. on December 1, 2018.

Email requests to complete the survey were sent from an email address created specifically for the study (RaystownLakeStudy@cdmsmith.com). The initial email was sent out on November 1, and email reminders were sent out on November 8 to individuals that had not already completed the survey. Some respondents had issues with getting timed-out of the web survey and the access codes not allowing them back into the survey. These individuals were emailed custom URLs that allowed them to edit their original responses.

Due to the procedures needed to contact the marina slip portion of the population, slip holders were contacted twice by mail using mixed-mode survey techniques of both mail and web surveys. The initial contact was a hard-copy paper instrument that included an invitation to participate in

the web survey, followed in one week by a postcard reminder with web survey information. The final number of surveys administered to marina users was 1,718.

Among the potential respondents that registered with USACE, some provided an email address and others only provided mailing addresses. A hard-copy paper instrument was mailed to those that only provided mailing addresses and reminder postcards were mailed one week later. Those that provided an email address were sent an email invitation to conduct the survey on-line and a follow-up email one week later. There were 51 emails returned undeliverable. Those for whom the email address could be corrected were resent, otherwise they were mailed a survey packet if a mailing address was available.

All campsite users from the USACE database had both email and mailing addresses. Therefore, an email invitation was sent to all campers to conduct the survey on-line and a followed-up with an email reminder a week later. Emails that were returned undeliverable were either corrected and resent or mailed a hard-copy paper instrument. After approximately two weeks, 332 surveys were mailed to public ramp users that did not respond to the initial email invitation and follow-up email. This was done to improve the response rate for the public ramp user subpopulation.

After approximately three weeks, there was a 45 percent response rate among boaters contacted through on-site canvassing but only a 12 percent response rate among campers, resulting in less than the target number of completed surveys by public ramp users. To account for this, the next 710 email addresses were drawn from the randomized list of campers and cross-checked with boaters contacted through the registered database, resulting in another 705 email invitations sent to campers. Of the 705 email invitations sent, 17 were returned as undeliverable email addresses, leaving 688 additional potential respondents contacted. In total, there 1,840 survey invitations sent to public ramp users.

Responses received through the postal mail were added to the online database using the surveygizmo.com interface. Quality checking procedures were employed to ensure accuracy of entered data.

A.1.5 Quality Procedures

To ensure quality and reduce potential error that was possible during the survey administration process, quality discussions occurred between the Project Manager and Program Manager. Potential sources of error were identified, and a mitigation plan was developed.

The greatest potential was determined to be in collection and entry of the surveys received via postal mail. The following steps were taken to reduce and mitigate potential error:

- As surveys were received, each was stamped with the date received.
- The same trained technician handled and entered all paper surveys received to reduce potential entry error and ensure consistency in entry.
- Survey responses were recorded per the date received, with the first surveys received entered first, and so on.

- As survey responses were entered via the online survey interface, each paper survey was clearly marked as recorded and initialed by the technician and filed per date received.
- Independent checking was conducted on approximately 5 percent of the surveys that were entered into the database by the administrators. Knowing the IP address of the entry technician, 35 surveys entered by the technician were independently checked and verified. Three errors in total were found, representing 8 percent of those checked. Entry errors were documented and corrected in the response database.
- A procedure was established for dealing with responses received past the open period. Responses were marked as such and filed per the date received.

A.2 Raystown Lake Survey Questionnaire

This section provides the mail questionnaire. Questions for the online version were exact, with question skipping built into the design.

SUMMER BOATING EXPERIENCE AT RAYSTOWN LAKE

U.S. Army Corps of Engineers Survey

OMB Control #: 0596-0236 Expiration Date: 11/30/2020

Raystown Lake is located on the Juniata River in south-central Pennsylvania. The U.S. Army Corps of Engineers (Corps) is the steward of the lands and waters around Raystown Lake and is responsible for providing the public with quality outdoor recreation experiences.

We would like your feedback to better understand your experiences and preferences regarding Raystown Lake! This survey will provide insight for the Raystown Lake Master Plan Revision which will guide management of the project into the future.

The survey is brief and will take approximately 12 minutes to complete. Please complete this paper survey and return in the paid envelope provided or you may drop the completed survey off at the Raystown Visitor Center. Responses will be accepted until November 30, 2018. We kindly ask that you complete the survey at your earliest convenience.

If you would like to complete this survey online, please use the following website with this onetime access code:

[redacted] Access Code: _____

If you have questions about the survey or would like more information, please contact:

[redacted]

THANK YOU FOR HELPING WITH THIS IMPORTANT EFFORT TO UNDERSTAND PEOPLE'S EXPERIENCES AND PREFERENCES FOR BOATING AT RAYSTOWN LAKE

Agency Disclosure Statement

The public reporting burden for this collection of information, 0596-0236, is estimated to average 12 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or burden reduction suggestions to the Department of Defense, Washington Headquarters Services, at whs.mc-alex.esd.mbx.dd-dod-information-collections@mail.mil. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT MAIL RESPONSES TO THE ABOVE ADDRESS

Completed survey responses should be mailed to:

CDM Smith – Raystown Lake Survey
[redacted]

Privacy Act Statement

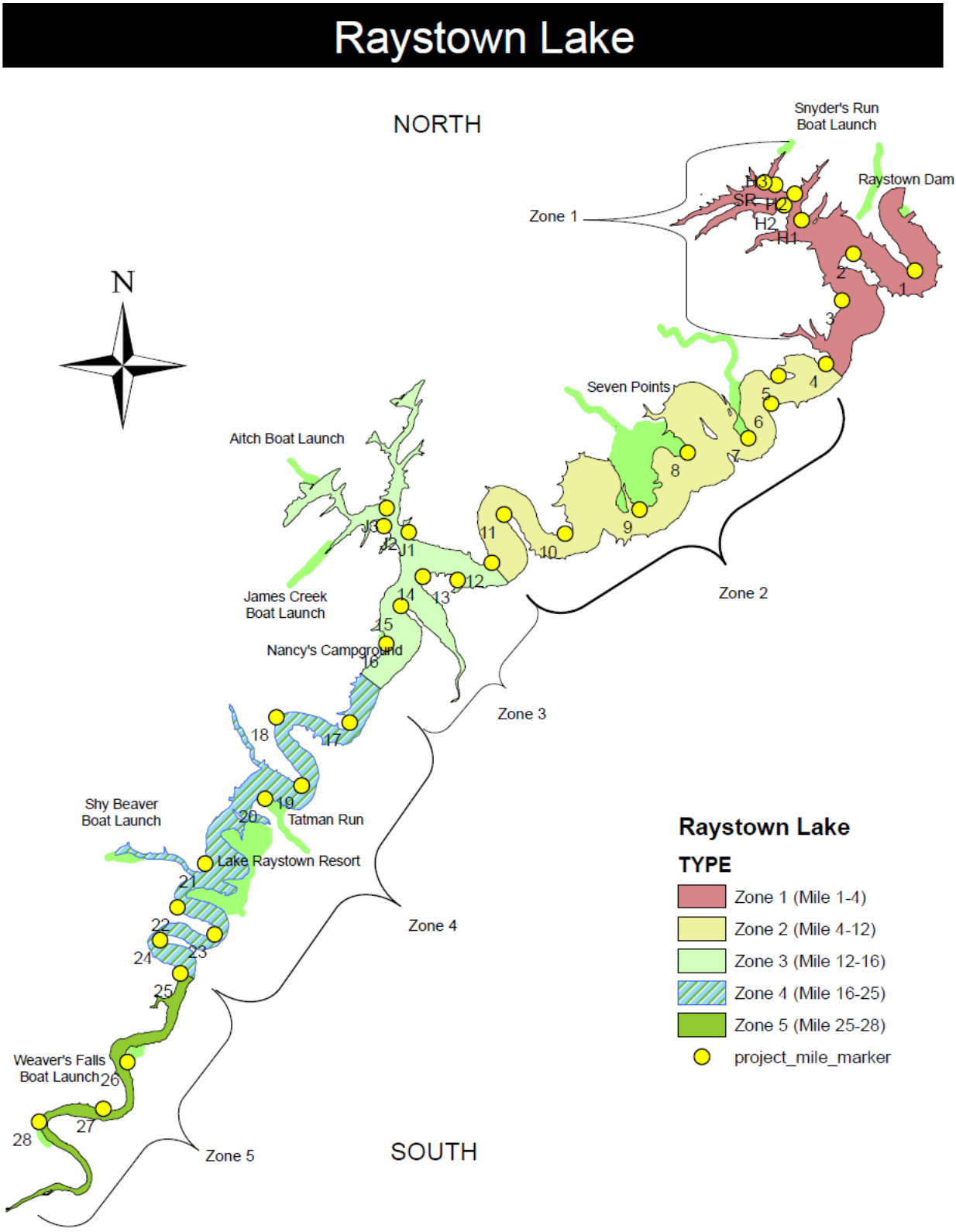
Authority: The Flood Control Act of 1944, as amended; 33 U.S.C. 652, Engineer Regulations 1130-2-550 Recreation Operations and Maintenance Policies and 1130-2-540 Environmental Stewardship Operations and Maintenance Policies

Principal Purpose: The information you provide will be combined with other visitor's information to understand opinions and preferences related to boating at Raystown Lake as part of a larger master planning effort.

Routine Use: No personally identifiable information is collected as part of this survey. For more information on DOD routine uses, visit http://dpcld.defense.gov/Privacy/SORNsIndex/Blanket-Routine-Uses/

Disclosure: Participation in this survey is voluntary and there are no penalties for refusing to provide any information. If you do not provide a response, it may affect the completeness and accuracy of the statistical results.

Please continue to the next page



Please reference this map when answering Questions 7-9 and 12-14.

Raystown Lake Boater Survey Access Code: _____

A. User Characteristics

1. Where do you live? (provide information for your primary residence)

_____ _____ _____ _____

City State Zip Code Country (if not US)

2a. Which of the following activities have you participated in during your trip(s) to Raystown Lake? (*Check one box for each item*)

	Participate In	Do Not Participate In
A. Boating	☐	☐
B. Walking/Short hike (less than 1 hour)	☐	☐
C. Day hiking (more than 1 hour)	☐	☐
D. Backpacking (# of nights): _____	☐	☐
E. Camping	☐	☐
F. Picnicking	☐	☐
G. Swimming	☐	☐
H. Shoreline Fishing	☐	☐
I. Mountain biking	☐	☐
J. Creative arts (photography/drawing/ painting/writing)	☐	☐
K. Other (Please specify): _____	☐	☐

2b) Which of the activities listed in Question 2a is generally your **primary** activity at Raystown Lake?

Letter of primary activity: _____ (from list above)

For Boating (row A, question 2a above), if you selected:

"Participate in" - please continue to question 3 on the next page.

"Do Not Participate in" - please skip to Questions 27-29 on page 9.

B. Boating Questions

3. How many years have you been boating? *(Round up)* _____ Years

4. How many years have you been boating on Raystown Lake? *(Round up)* _____ Years

5. How often do you engage in boating activities on Raystown Lake? *(Mark one)*

- ☐ First time
- ☐ Less than once per year
- ☐ 1-5 times per year
- ☐ 6-10 times per year
- ☐ 11-15 times per year
- ☐ 16-20 times per year
- ☐ 21 times or more per year

6. How experienced are you in the operation of a boat? (*Mark only one*)

☐ Very inexperienced ☐ Inexperienced ☐ Experienced ☐ Very experienced

7. During a typical boating trip on Raystown Lake, please indicate the primary area where you (and your group) do most of your recreation activities. Use the map included with this survey as a reference. (*Mark only one zone*)

Zone 1 (Mile Markers 1-4) ☐	Zone 2 (Mile Markers 4-12) ☐	Zone 3 (Mile Markers 12-16) ☐	Zone 4 (Mile Markers 16-25) ☐	Zone 5 (Mile Markers 25-28) ☐	No primary location ☐

8. Generally, where do you (and your group) enter Raystown Lake for boating? Use the map included with this survey as a reference. (*Mark only one zone*)

Zone 1 (Mile Markers 1-4) ☐	Zone 2 (Mile Markers 4-12) ☐	Zone 3 (Mile Markers 12-16) ☐	Zone 4 (Mile Markers 16-25) ☐	Zone 5 (Mile Markers 25-28) ☐	No primary location ☐

9. What is the **farthest mile marker** you reach in both directions on a typical boating trip? Use the map included with this survey as a reference. Mile markers are the yellow circles. Please enter the value next to the circle that represents the:

_____ Northern-most Mile Marker you reach _____ Southern-most Mile Marker you reach

Please continue to the next page

10. Please provide the type and size of the primary boat used by you and other persons in your party at Raystown Lake and whether this boat was trailered to the lake or kept at a marina on the lake.

<table>
<tr>
<td>Boat Type
(Mark one)
☐ I don't know
☐ Speedboat
☐ Ski or wake boat
☐ Fishing boat/bass boat
☐ Pontoon boat
☐ House boat
☐ Cabin cruiser
☐ Sailboat
☐ Personal watercraft (e.g. Jet Ski)
☐ Kayak/canoe
☐ Other _____</td>
<td>Boat Size
(Mark one)
☐ less than 16'
☐ 16 - 20'
☐ 21 - 28'
☐ 29'+</td>
<td>Was this boat transported (e.g., trailered or car/truck roof) to the lake? (Mark one)
☐ Trailered/transported to the lake
☐ Kept at a marina on the lake
Marina_____
Slip #_____

Do you own, rent or borrow your boat?
(Mark one)
☐ Own
☐ Rent
☐ Borrow

Where do you store your boat? (Mark one)
☐ Marina
☐ Private Parking Lot/Storage Facility
☐ Private Residence</td>
</tr>
</table>

11. On a typical visit, what percent of your time do you spend on the following activities while boating on Raystown Lake? (As an example, please consider time spent getting to or moving between fishing locations as "Fishing".)

Fishing	_____ %
Cruising	_____ %
Swimming	_____ %
Water Skiing	_____ %
Relaxing/Sunning in boat (stationary)	_____ %
Other activities	_____ % ...please describe _____

(BE SURE THE TOTAL = 100%)

Please continue to the next page

12. Do you have a favorite location to go on Raystown Lake? ☐ No ☐ Yes

If Yes, describe below:

Name of favorite location: _____

Why is that your favorite location: _____

_____

Mile Marker: _____ (Use the map as a reference, mail markers are yellow numbered circles)

13. Are there any locations on Raystown Lake that you deliberately avoid? ☐ No ☐ Yes

If Yes, describe below:

Name of location to avoid: _____

Why do you avoid that/those location(s): _____

_____

Mile Marker(s): _____ ((Use the map as a reference, mail markers are yellow numbered circles)

14. Are there any locations on Raystown Lake where you feel unsafe? ☐ No ☐ Yes

If Yes, describe below:

Name of location is unsafe: _____

Why do you feel unsafe at that/those location(s): _____

_____

Mile Marker(s): _____ (Use the map as a reference, mail markers are yellow numbered circles)

15. On a scale of 1 to 10 (with 10 being the perfect trip), how would you generally rate the quality of your boating experience? _____

Please continue to the next page

C. Management Questions

16. How much of a problem is there from too many boats on the lake? (*Check one*)

☐ Not a Problem at All ☐ Small Problem ☐ Moderate Problem ☐ Big Problem

17. How safe do you generally feel while boating or launching your boat at the following locations? (*Circle number that reflects your opinion for each location*)

Location	Not at all safe	Somewhat safe	Moderately safe	Extremely safe	Not applicable
At the boat ramp	1	2	3	4	NA
On the water	1	2	3	4	NA
At the marina	1	2	3	4	NA

18. How crowded do you generally feel at the following locations?
(*Circle number that reflects your opinion for each location*)

Location	Not at all crowded	Somewhat crowded	Moderately crowded	Extremely crowded	Not applicable
At the boat ramp	1	2	3	4	NA
On the water	1	2	3	4	NA
At the marina	1	2	3	4	NA

19. How much, if at all, has the noise from other boats reduced your enjoyment of Raystown Lake? (*Mark one*)

Not at All	Slightly	Somewhat	Quite a Bit	Extremely
☐	☐	☐	☐	☐

20. How likely is it that the presence of too many boats would cause you to avoid your favorite parts of Raystown Lake? (*Mark one*)

Not at All Likely	Slightly Likely	Somewhat Likely	Quite Likely	Extremely Likely
☐	☐	☐	☐	☐

Please continue to the next page

21. For each of the following, please indicate if you feel that at Raystown Lake there are too few, adequate, too many, or don't know. (*Select one answer for each statement)*

Boat Ramps	☐ Too few	☐ Adequate	☐ Too many	☐ Don't know
Parking Areas	☐ Too few	☐ Adequate	☐ Too many	☐ Don't know
Waterways Conservation Officers	☐ Too few	☐ Adequate	☐ Too many	☐ Don't know
Park Rangers	☐ Too few	☐ Adequate	☐ Too many	☐ Don't know
Marinas	☐ Too few	☐ Adequate	☐ Too many	☐ Don't know

22. Have you noticed any positive or negative changes at this lake in the last five years?
If you have, please describe the changes:

Positive: _____

Negative: _____

If you have noticed changes, have these changes affected your enjoyment or use of Raystown Lake?

Positive: _____

Negative: _____

23a. Which of these statements best describes your **expectation** for the number of boats on Raystown Lake? Please refer to your last outing on the lake when answering this question. (*Mark one*)

- ☐ I saw FEWER boats than I expected to see that day
- ☐ I saw ABOUT AS MANY boats as I expected to see that day
- ☐ I saw MORE boats than I expected to see that day

23b. Please indicate the date of your last outing:

_____(month) _____(day) _____(year)

Please continue to the next page

24. Which of these statements best describes your **preference** for the number of boats on the lake? Please refer to your last outing on the lake when answering this question. (*Mark only one*)

- ☐ I saw ABOUT AS MANY boats than I wanted to see that day
- ☐ I saw FEWER boats as I wanted to see that day
- ☐ I saw MORE boats than I wanted to see that day

25. To what extent do you agree or disagree with each of the following statements? (*Circle number that reflects your level of agreement for each statement*)

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a) I generally stay off the lake during parts of the day/week because there are too many boats on the lake.	1	2	3	4	5
b) My boating trips are generally not as enjoyable as I expect them to be.	1	2	3	4	5
c) There are generally an unsafe number of boats on the water.	1	2	3	4	5
d) Other boats generally come closer to my boat than I like.	1	2	3	4	5
e) My boat trip(s) are generally well worth the money I spend to take them.	1	2	3	4	5
f) The behavior of other boaters generally interfered with the quality of my boating experience.	1	2	3	4	5
g) I generally do not like the amount of time I have to wait to get on the water.	1	2	3	4	5
h) Boating conditions on the lake are generally safe.	1	2	3	4	5
i) All boaters should be required to wear a Personal Floatation Device (PFD) while boating.	1	2	3	4	5
j) I generally do not participate in some boating activities because of crowded conditions at the lake.	1	2	3	4	5
k) The size of the boats that I generally see on Raystown Lake is acceptable in terms of my experience.	1	2	3	4	5
l) The speed used by other boaters is generally safe.	1	2	3	4	5

Please continue to the next page

26. Which photo shows the maximum number of boats you could see at one time on Raystown Lake WITHOUT thinking it was crowded? (*Circle one*)

A	B	C	D	E	I don't think it looks crowded in any of the photos

A

B

C

D

E

Please continue to the next page

D. Basic Demographics

27. What is your gender? (*Mark one*) ☐ Female ☐ Male ☐ Other

28. What is your age? (*Mark one*)

- ☐ Under 18
- ☐ 18 – 24
- ☐ 25 – 44
- ☐ 45 – 54
- ☐ 55 – 64
- ☐ 65+

29. Please indicate the highest level of education you have completed? (*Mark one*)

- ☐ Less than high school
- ☐ High school graduate/GED
- ☐ Vocational or Technical School certificate
- ☐ Associates degree
- ☐ Some college
- ☐ Bachelor's degree
- ☐ Graduate degree or professional degree (MA, MS, PhD, JD, MBA etc.)

Thank you for taking the time to complete this survey. Your responses are important and will help inform the future management of Raystown Lake.

Please return your completed survey in the postage paid envelope provided.

A.3 Raystown Lake Survey Responses

A.3.1 Total Responses Received

After removal of partially completed responses, there were 1,367 completed survey responses (38 percent response rate). The number of eligible boaters was 1,278. The marina user subpopulation had 856 responses (50 percent response rate for marina users, representing 67 percent of respondents) and the public ramp user subpopulation had 382 responses (21 percent response rate for ramp users, representing 30 percent of respondents). Note that 3 percent of respondents who were boaters did not indicate if they used a marina or a public ramp to access the lake.

A.3.2 Post-Response Sample Balancing

The higher response rate among the marina subpopulation resulted in a potential oversampling bias of the final results toward marina users. This potential bias was corrected by post-stratification of the responses. The two user groups were balanced in proportion to their estimated use rate of Raystown Lake (45 percent for marina users and 55 percent for public ramp users). Therefore, 313 responses from the marina user subpopulation were randomly selected for analysis and all 382 responses from the public ramp user subpopulation were analyzed. This technique results in better representation of the population which the survey is attempting to study and reduces bias among subpopulations. The resulting sample of 695 exceeded the target sample size of 688 identified above in Section A.1.3. However, 18 of the responses were found to be incomplete for statistical analysis, thus reducing the statistical analysis to a sample of 677, which is sufficient in size to assume a 5 percent margin of error with a 95 percent level of confidence in the statistical analysis.

A.3.3 Response Statistics by Question

Response statistics presented here-in represent the post-survey balanced sample drawn from the total responses, as described in the previous section. Additional analysis of results by user-type and lake access are provided in the main report.

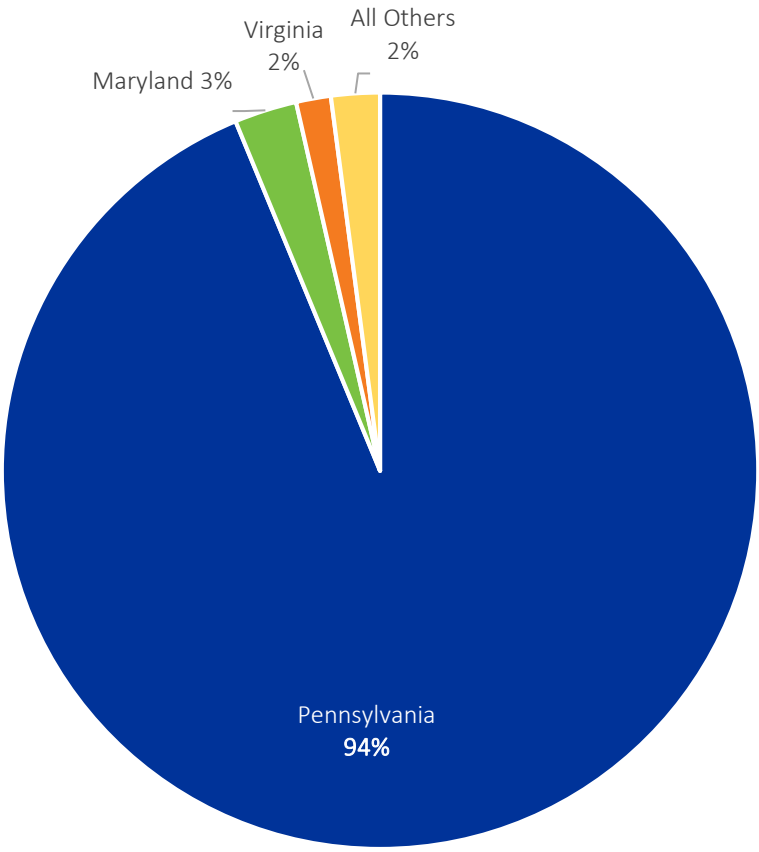
Nonresponse statistics are included for each question. Most questions had less than 10 nonresponses. The exceptions include:

- Question 17 - How safe do you generally feel while boating or launching your boat at the following locations? - 55 nonresponses (8 percent)
- Question 18 - How crowded do you generally feel at the following locations? - 52 nonresponses (8 percent)
- Question 25 – A number of statements that respondents were asked if they agreed with – nonresponses between 23-42 (3-6 percent)

1. Where do you live?

City	No.	%		City	No.	%		City	No.	%		City	No.	%
Huntingdon	41	6%		Sidman	6	1%		Ebensburg	3	<1%		Warriors Mark	3	<1%
Altoona	25	4%		Elizabethtown	5	1%		Enola	3	<1%		Not Disclosed	3	<1%
Johnstown	23	3%		Greensburg	5	1%		Everett	3	<1%		Alexandria	2	<1%
Harrisburg	19	3%		James Creek	5	1%		Hershey	3	<1%		Arlington	2	<1%
Hollidaysburg	17	2%		Manheim	5	1%		Howard	3	<1%		Auburn	2	<1%
Tyrone	14	2%		Pittsburgh	5	1%		Lebanon	3	<1%		Bedford	2	<1%
Chambersburg	13	2%		Aspers	4	1%		Lewisberry	3	<1%		Bethel Park	2	<1%
State College	13	2%		Bellefonte	4	1%		Lititz	3	<1%		Bethlehem	2	<1%
Shippensburg	12	2%		Dillsburg	4	1%		Mapleton Depot	3	<1%		Boalsburg	2	<1%
Lancaster	11	2%		Frederick	4	1%		Martinsburg	3	<1%		Boiling Springs	2	<1%
Duncansville	10	1%		Greencastle	4	1%		Mc Veytown	3	<1%		Cassville	2	<1%
Mechanicsburg	10	1%		Indiana	4	1%		Mineral Point	3	<1%		Chesterfield	2	<1%
York	10	1%		Marysville	4	1%		Murrysville	3	<1%		Coal Township	2	<1%
Hesston	8	1%		Mifflintown	4	1%		New Enterprise	3	<1%		Collegeville	2	<1%
Carlisle	7	1%		Spring Grove	4	1%		New Paris	3	<1%		Cresson	2	<1%
Lewistown	7	1%		Waynesboro	4	1%		Palmyra	3	<1%		Dauphin	2	<1%
Port Matilda	7	1%		Bloomsburg	3	<1%		Portage	3	<1%		Denver	2	<1%
Williamsburg	7	1%		Claysburg	3	<1%		Pottstown	3	<1%		Doylestown	2	<1%
Hummelstown	6	1%		Dover	3	<1%		Saint Thomas	3	<1%		East Berlin	2	<1%
Roaring Spring	6	1%		Downingtown	3	<1%		Saxton	3	<1%		All Others	242	35%

1. What state do you live in?



State	Percent	Count
Pennsylvania	93.8%	631
Maryland	2.7%	18
Virginia	1.5%	10
West Virginia	0.9%	6
Ohio	0.4%	3
Delaware	0.3%	2
Florida	0.1%	1
New York	0.1%	1
Washington, D.C.	0.1%	1
	Total	**673**

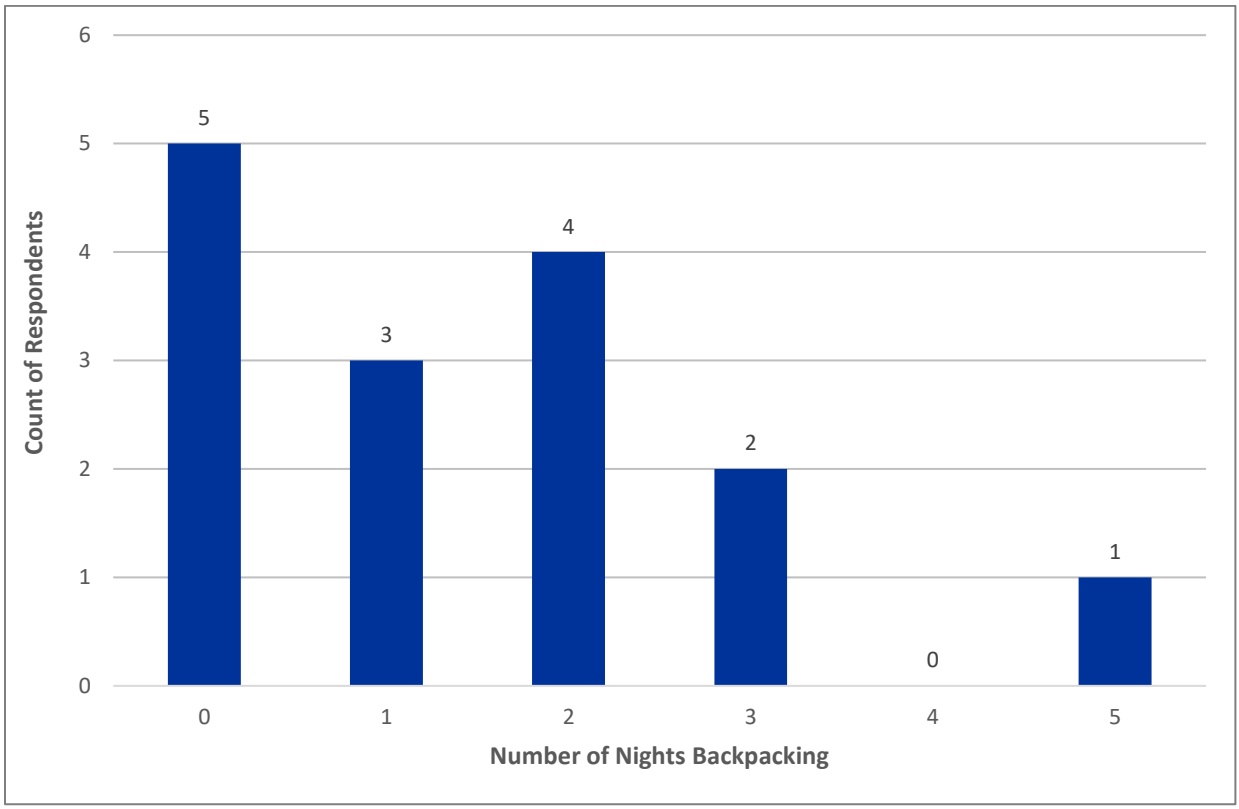
Nonresponse = 4

2a. Which of the following activities have you participated in during your trip(s) to Raystown Lake?

Value	Participate In		Do Not Participate In		Responses
	Row %	Count	Row %	Count	Count
Boating	100%	677	0%	0	677
Walking/Short Hike (less than 1 hour)	74.2%	502	25.8%	175	677
Day Hiking (more than 1 hour)	35.3%	239	64.7%	438	677
Backpacking	2.7%	18	97.3%	659	677
Camping	68.8%	466	31.2%	211	677
Picnicking	66.2%	448	33.8%	229	677
Swimming	90.0%	609	10.0%	68	677
Shoreline Fishing	48.0%	325	52.0%	352	677
Mountain Biking	17.9%	121	82.1%	556	677
Creative Arts (photography/drawing/painting/writing)	17.1%	116	82.9%	561	677
Other	20.4%	138	79.6%	538	676

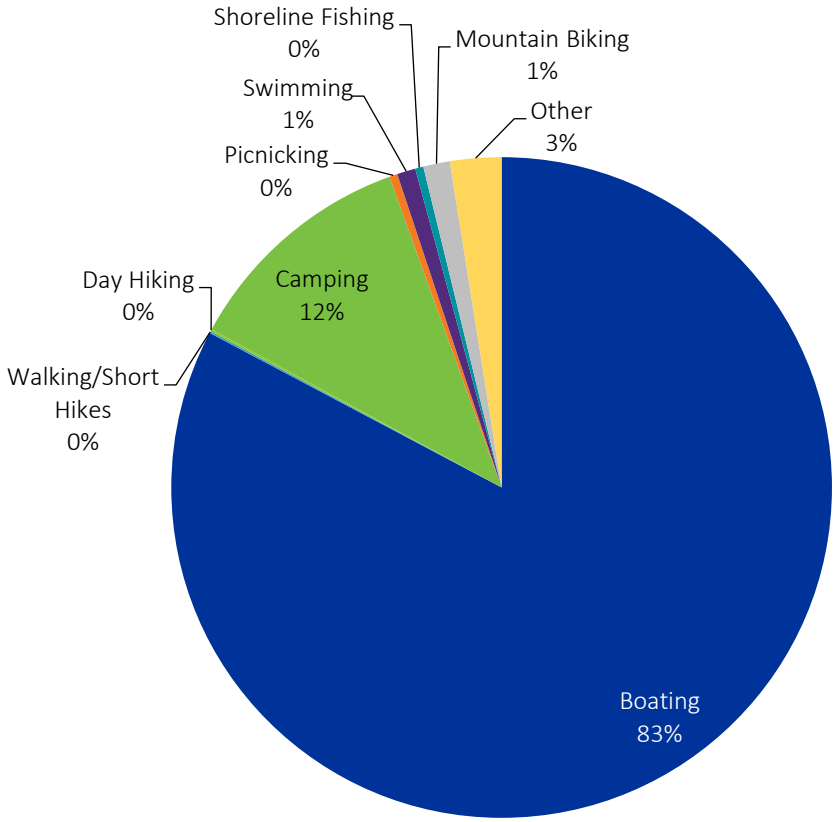
Nonresponse = 0

2.B. Number of nights spent backpacking?



Nonresponse = 0

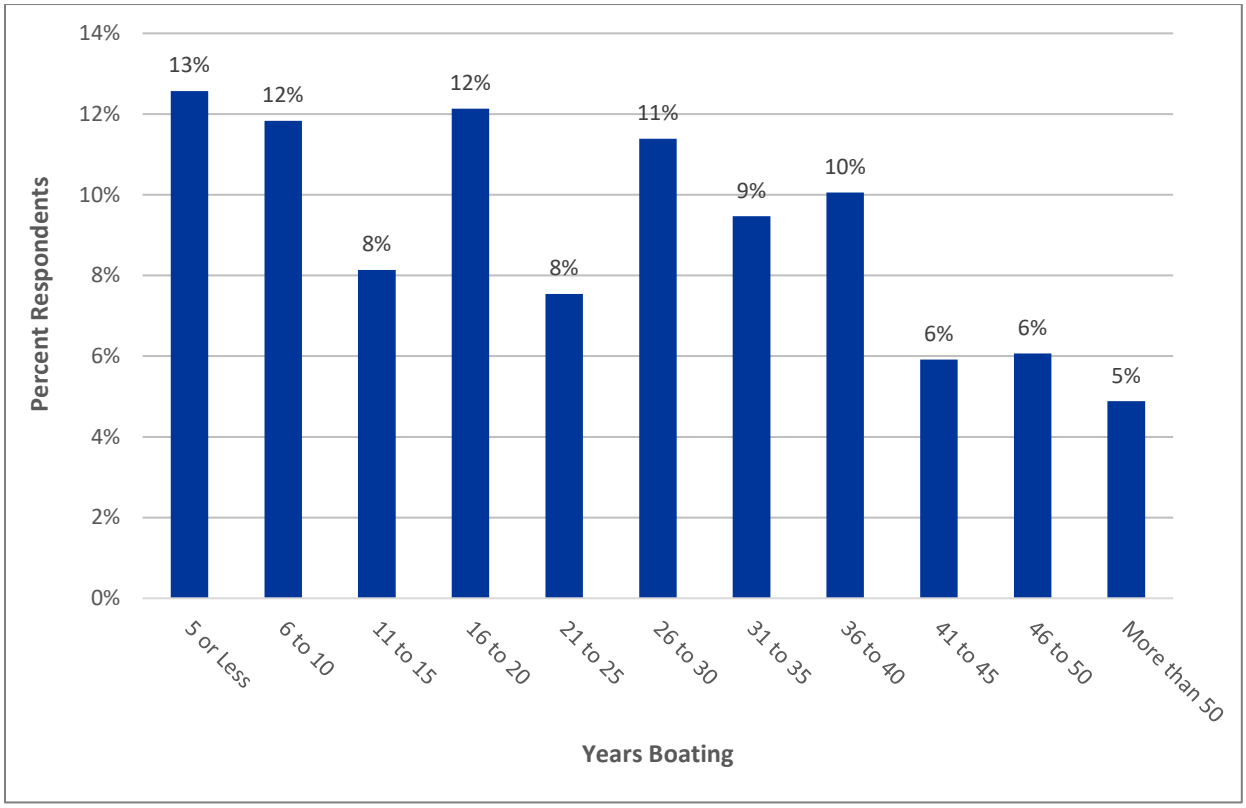
2c. Which of the activities listed is generally your primary activity at Raystown Lake?



Value	Percent	Count
Boating	82.5%	558
Walking/Short Hikes	0.1%	1
Day Hiking	0.1%	1
Camping	11.5%	78
Picnicking	0.4%	3
Swimming	0.9%	6
Shoreline Fishing	0.4%	3
Mountain Biking	1.3%	9
Other	2.5%	17
	Total	**676**

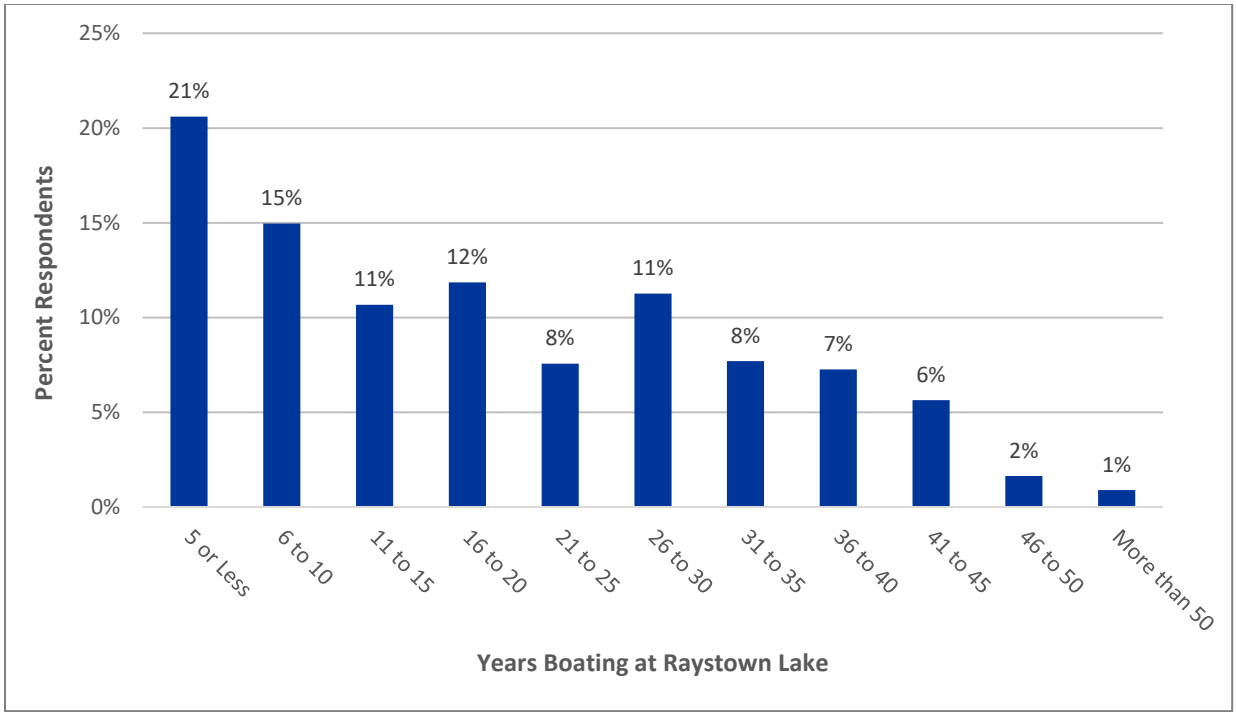
Nonresponse = 1

3. How many years have you been boating?



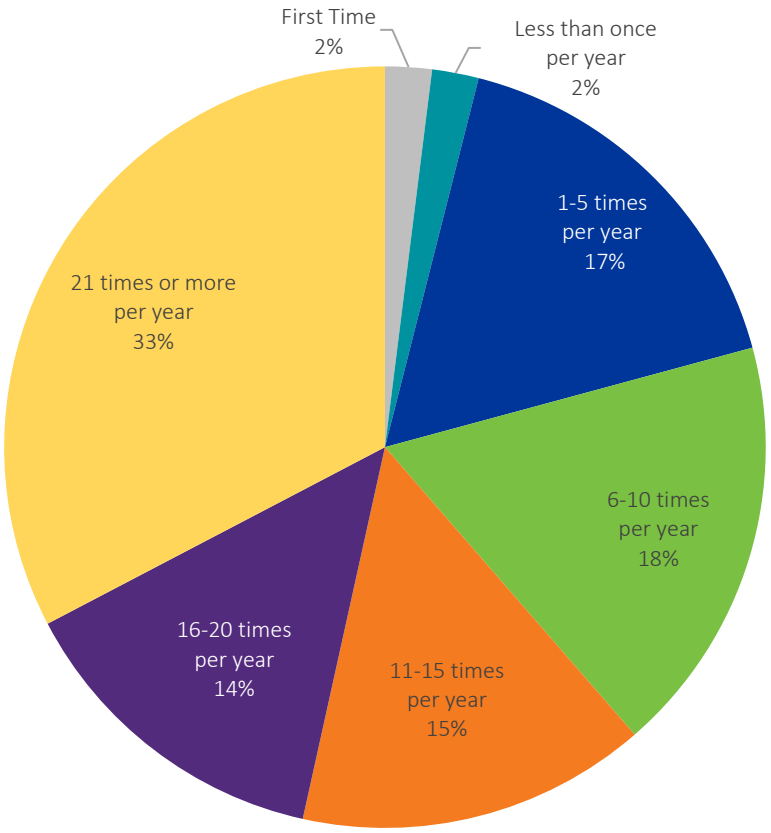
Nonresponse = 1

4. How many years have you been boating on Raystown Lake?



Nonresponse = 2

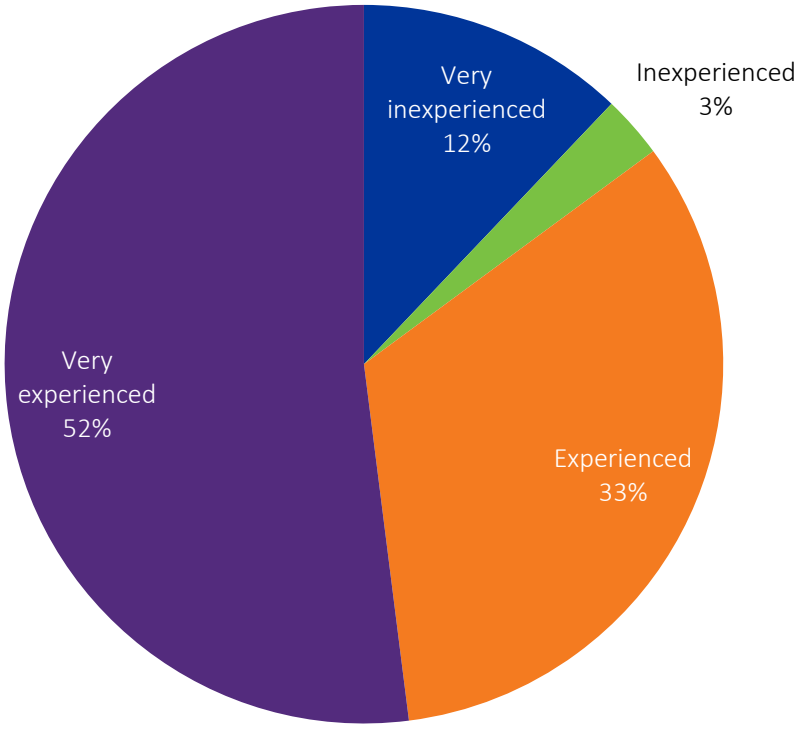
5. How often do you engage in boating activities on Raystown Lake?



Value	Percent	Count
First time	1.6%	11
Less than once per year	1.5%	10
1-5 times per year	17.1%	116
6-10 times per year	17.7%	120
11-15 times per year	14.9%	101
16-20 times per year	14.3%	97
21 times or more per year	32.8%	222
	Total	**677**

Nonresponse = 0

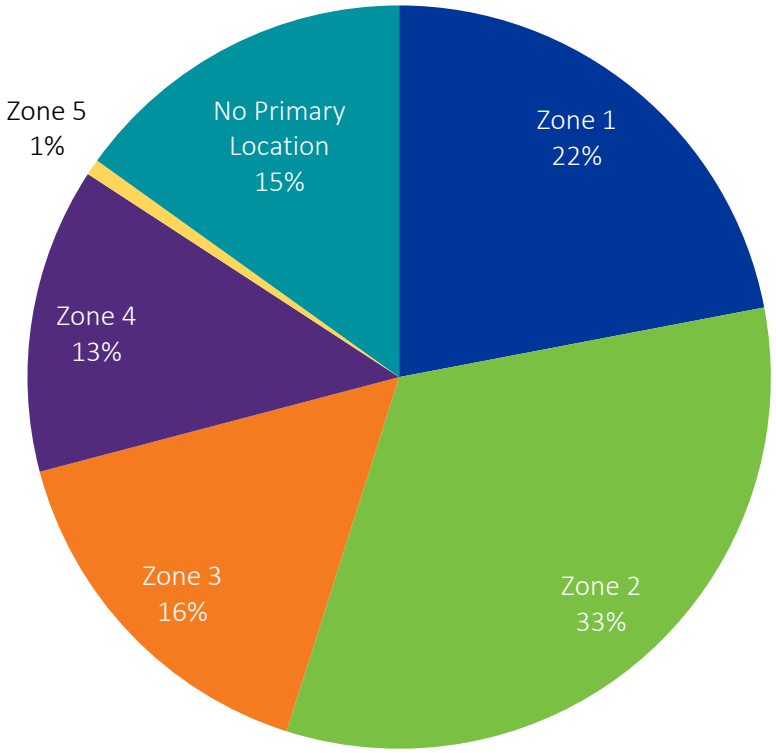
6. How experienced are you in the operation of a boat?



Value	Percent	Count
Very inexperienced	12.1%	82
Inexperienced	2.8%	19
Experienced	33.1%	224
Very experienced	52.0%	352
	Total	**677**

Nonresponse = 0

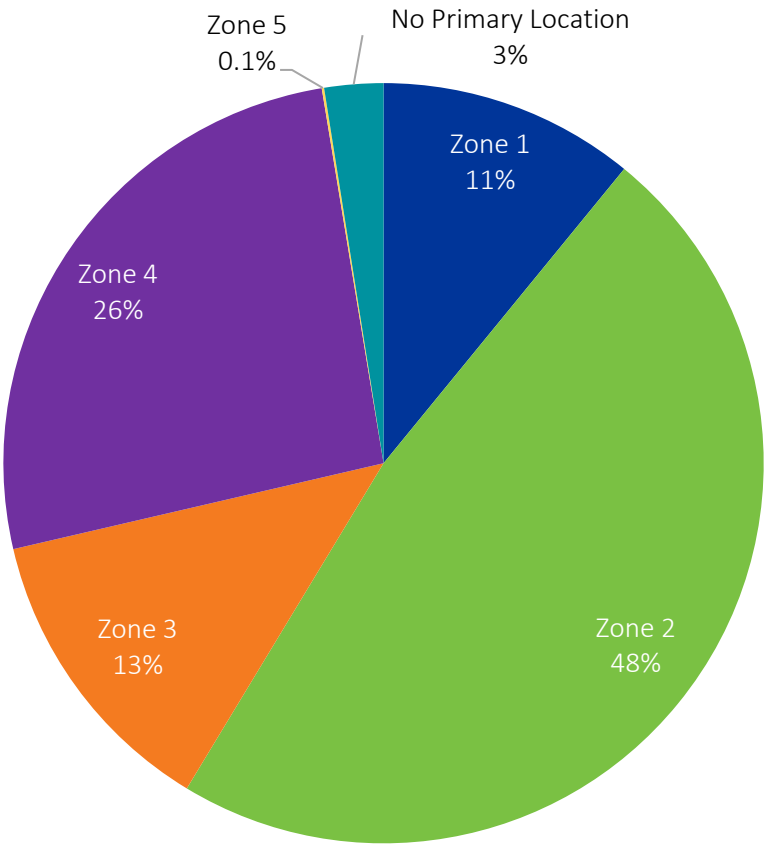
7. During a typical boating trip on Raystown Lake, what is the primary area where you (and your group) do most of your recreation activities?



Value	Percent	Count
Zone 1 (Mile Markers 1-4)	22.0%	149
Zone 2 (Mile Markers 4-12)	32.9%	223
Zone 3 (Mile Markers 12-16)	16.0%	108
Zone 4 (Mile Markers 16-25)	13.3%	90
Zone 5 (Mile Markers 25-28)	0.7%	5
No primary location	15.1%	102
	Total	**677**

Nonresponse = 0

8. Generally, where do you (and your group) enter Raystown Lake for boating?



Value	Percent	Count
Zone 1 (Mile Markers 1-4)	10.9%	74
Zone 2 (Mile Markers 4-12)	47.7%	323
Zone 3 (Mile Markers 12-16)	12.7%	86
Zone 4 (Mile Markers 16-25)	26.0%	176
Zone 5 (Mile Markers 25-28)	0.1%	1
No primary location	2.5%	17
	Total	**677**

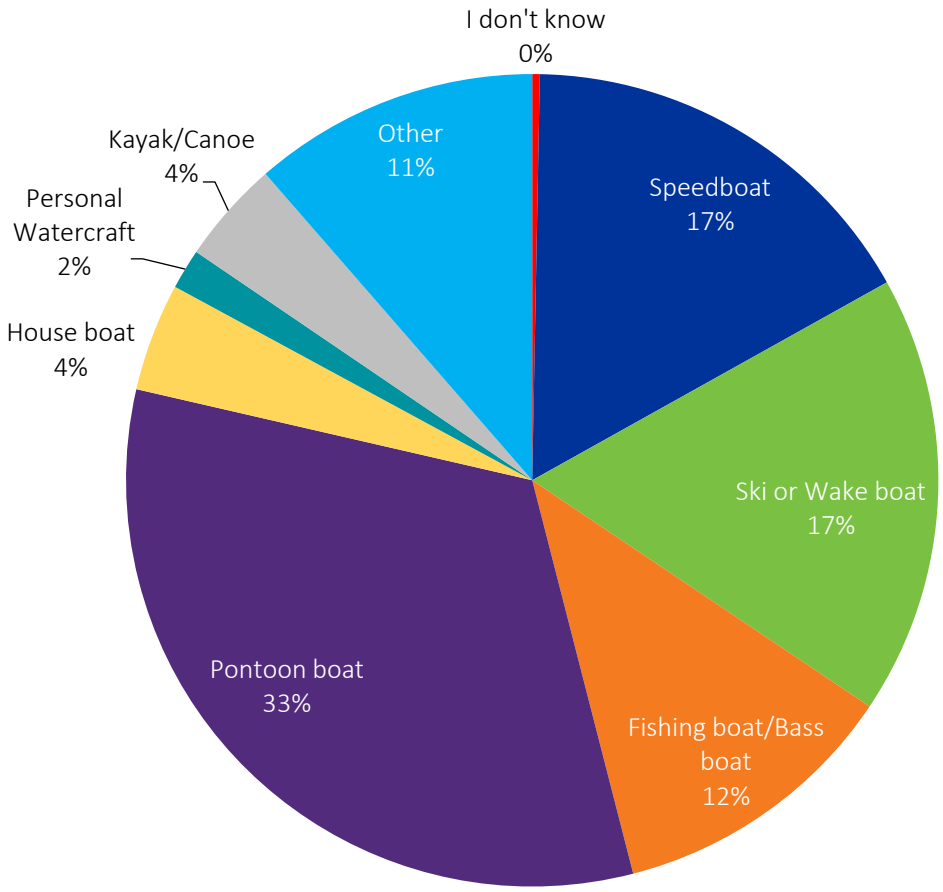
Nonresponse = 0

9. What is the farthest mile marker you reach in both directions on a typical boating trip?

Value	Northern-most mile marker you reach		Southern-most mile marker you reach	
	Row %	Count	Row %	Count
1	57.7%	389	3.0%	20
2	5.9%	40	1.0%	7
3	3.3%	22	2.4%	16
4	3.7%	25	4.6%	31
5	1.5%	10	2.5%	17
6	1.6%	11	0.0%	0
7	3.0%	20	0.3%	2
8	2.7%	18	3.0%	20
9	1.0%	7	3.6%	24
10	1.6%	11	4.3%	29
11	1.0%	7	1.2%	8
12	2.5%	17	2.4%	16
13	0.1%	1	1.3%	9
14	0.7%	5	4.5%	30
15	0.1%	1	2.2%	15
16	0.3%	2	4.8%	32
17	0.7%	5	1.5%	10
18	0.1%	1	0.6%	4
19	0.3%	2	0.7%	5
20	0.1%	1	4.0%	27
21	0.7%	5	11.0%	74
22	0.4%	3	4.3%	29
23	0.1%	1	1.6%	11
24	0.1%	1	3.0%	20
25	0.0%	0	13.8%	93
26	0.1%	1	7.4%	50
27	0.4%	3	1.6%	11
28	0.7%	5	7.4%	50
H1	0.3%	2	0.1%	1
H2	4.7%	32	0.3%	2
H3	2.5%	17	0.0%	0
J1	0.1%	1	0.0%	0
J2	0.1%	1	0.3%	2
J3	1.0%	7	1.2%	8

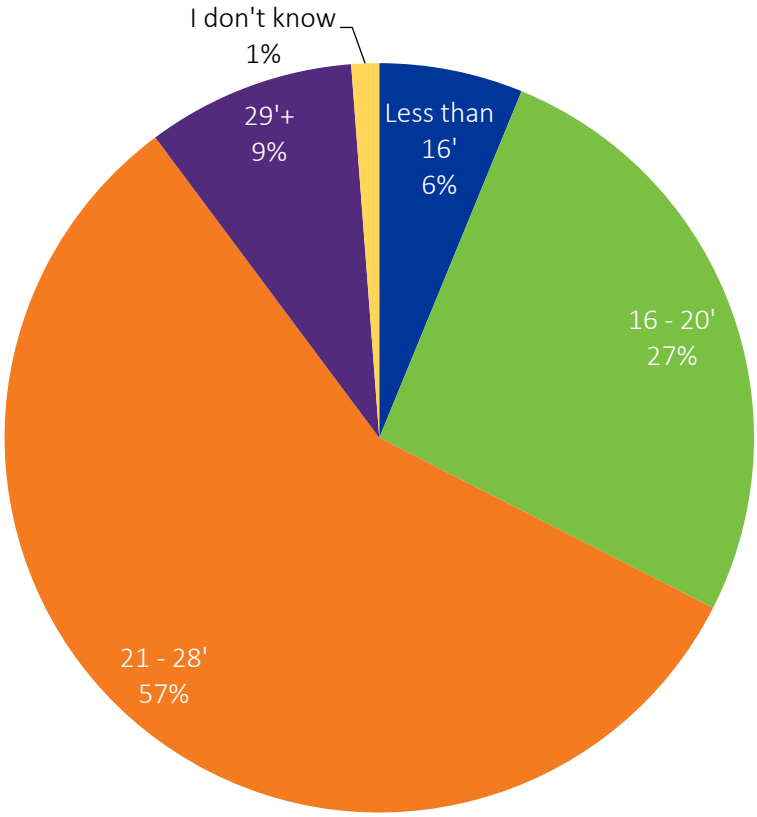
Nonresponse = 3 (northernmost); 4 (southernmost)

10a. What type of boat is the primary boat used by you and other persons in your party at Raystown Lake?



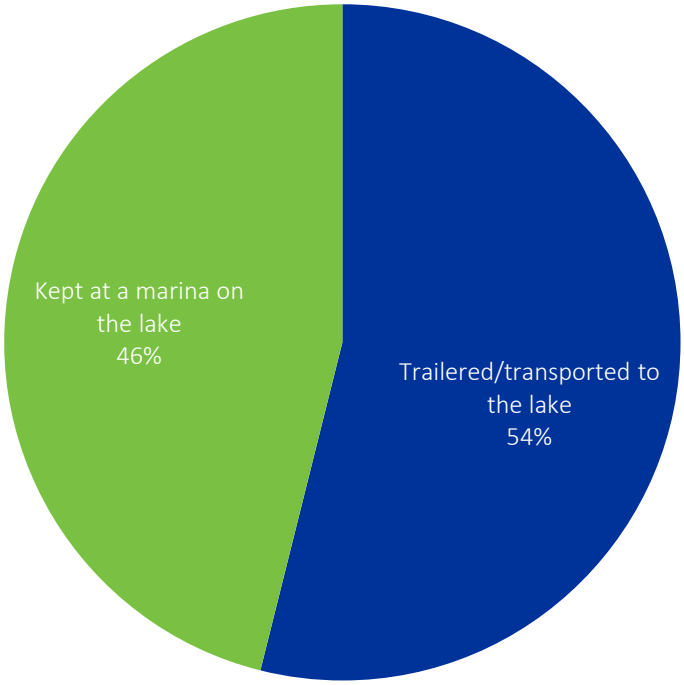
Nonresponse = 2

10b. What is the size of the primary boat used by you and other persons in your party at Raystown Lake?



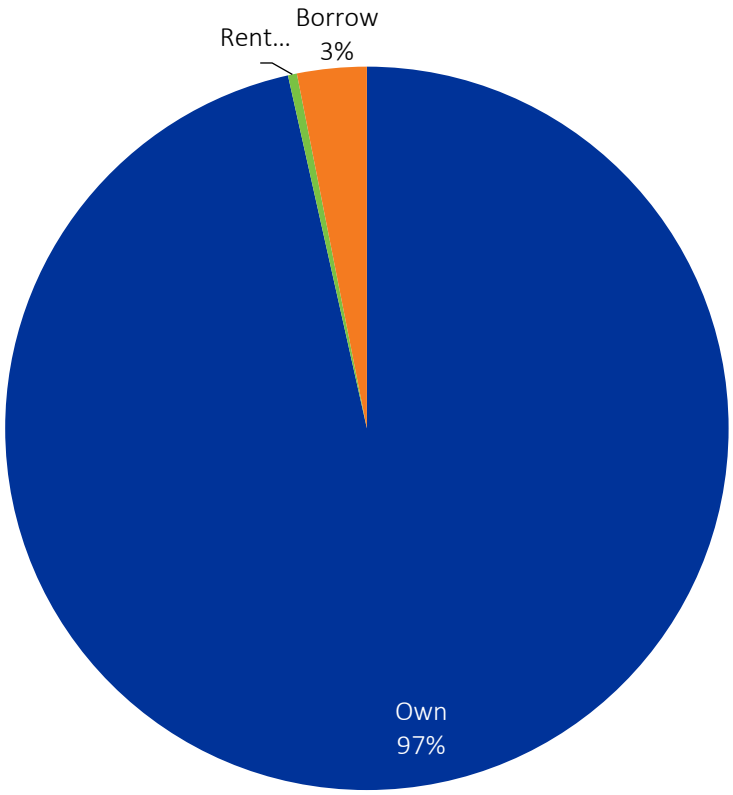
Nonresponse = 0

10c. Was this boat transported (e.g. trailered or car/truck roof) to the lake?



Nonresponse = 0

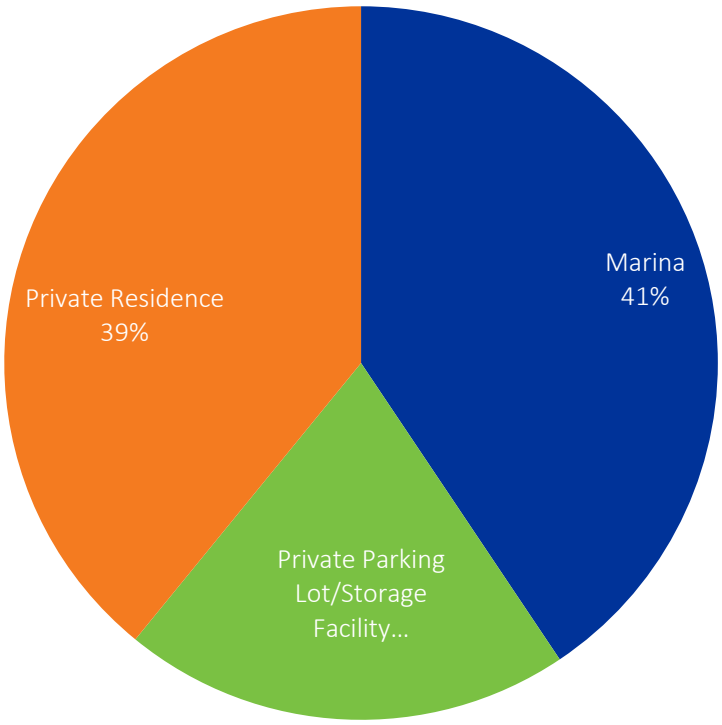
10d. Do you own, rent, or borrow your boat?



Value	Percent	Count
Own	96.4%	650
Rent	0.4%	3
Borrow	3.1%	21
	Total	**674**

Nonresponse = 3

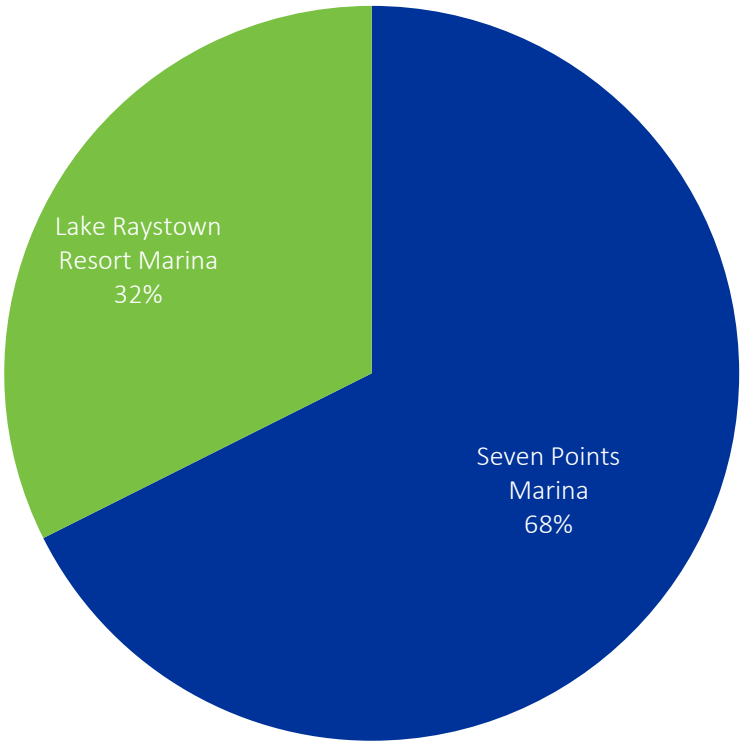
10e. Where do you store your boat?



Value	Percent	Count
Marina	40.6%	262
Private Parking Lot/Storage Facility	20.3%	131
Private Residence	39.1%	252
	Total	**645**

Nonresponse = 32

10f. Please select the marina where you keep your boat:



Value	Percent	Count
Seven Points Marina	67.6%	175
Lake Raystown Resort Marina	32.4%	84
	Total	259

Nonresponse = 3

11a. On a typical visit, what percent of your time do you spend on the following activities while boating on Raystown Lake?

Value	Average	Total Responses
Fishing	24.2%	437
Cruising	26.3%	594
Swimming	22.3%	575
Water Skiing	13.0%	334
Relaxing/Sunning in a Boat	35.6%	591
Other Activities	15.8%	185

Note: The average column is the average percentage that respondents indicated they spend on each activity. Therefore, the total is greater than 100 percent.

Nonresponse = 0

11b. If you participate in other activities while boating on Raystown Lake, please describe them:

Value	Percent	Count
Tubing	27.1%	49
Jet Ski	9.9%	18
Kayak	7.2%	13
Picnic	7.2%	13
Walking/hiking	6.1%	11
Marina/Resort activities	5.0%	9
Camping	5.0%	9
Photography	4.4%	8
Paddling (Paddle boarding)	3.9%	7
Exploring/sight-seeing	3.9%	7
Bird watching (and other wildlife)	3.9%	7
Getting to hunting locations	2.8%	5
Overnight boating	2.8%	5
Wakeboarding	2.2%	4
Biking	2.2%	4
Geocaching	1.7%	3
Cliff jumping	1.7%	3
Reading/writing	1.7%	3
Picking up garbage	1.1%	2
Snorkeling	0.6%	1
	Total	259

Note: The question was about other activities engaged in <u>while</u> boating. However, many respondents included activities that they participate in but not while they are boating. For reporting purposes, all responses are included in this table.

Nonresponse = 0

12a. Do you have a favorite location to go on this lake?

Value	Percent	Count
Yes	68.7%	465
No	31.3%	212
	Total	677

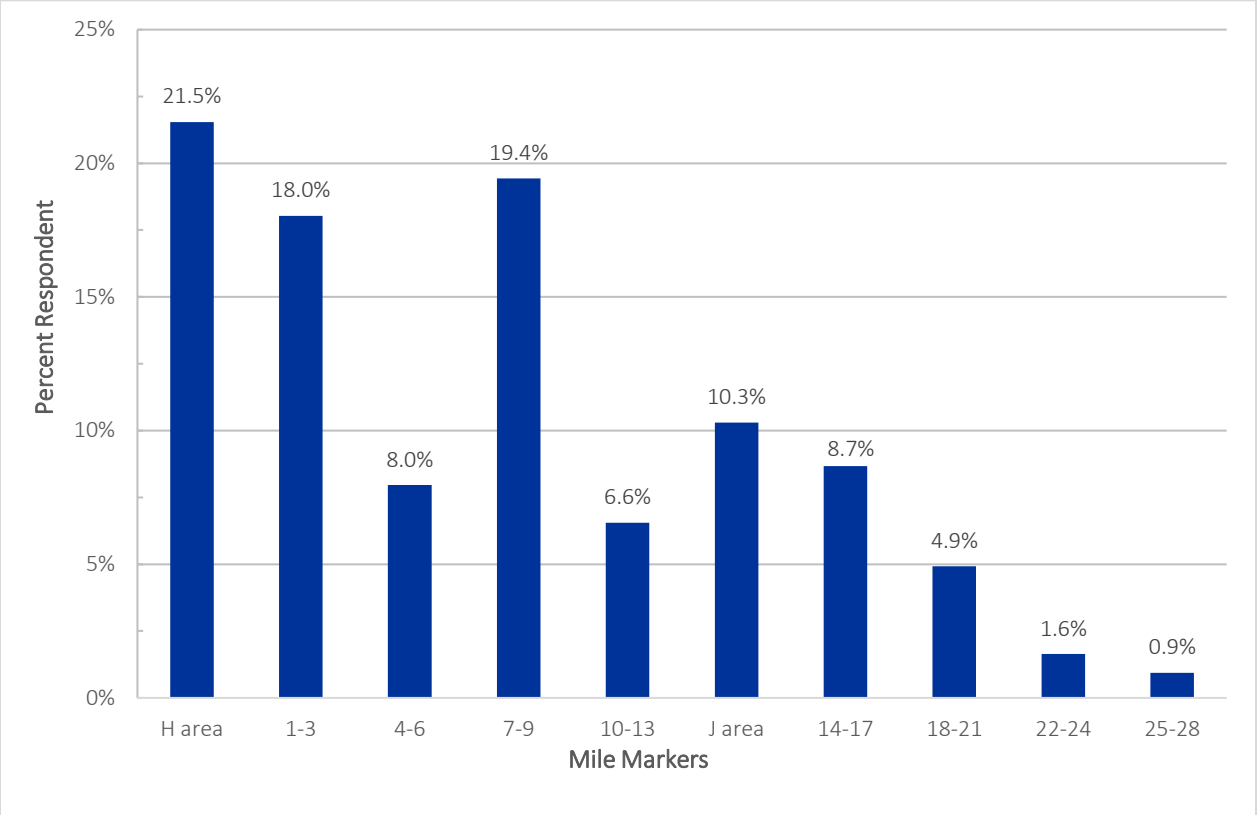
Nonresponse = 0

12b. Why is that your favorite location?

Value	Percent	Count
Quiet/ Peaceful	11.7%	86
No-wake area/no wake from other boats	11.5%	84
Less crowded/less boat traffic	10.8%	79
Area to moor/tie-off	8.6%	63
Clean	8.1%	59
Relaxing	7.8%	57
Swimming	7.5%	55
Good fishing	6.3%	46
Wildlife/Bird Watching/ Nature	5.3%	39
Friends/gathering place	5.3%	39
Close to marina/ boat launch/ campground	3.8%	28
More area for recreation	3.7%	27
Family Friendly/kids enjoy location	3.3%	24
Easy access/convenient location	2.9%	21
Protection from wake/weather	1.8%	13
Cliff jumping	1.2%	9
Safe	0.4%	3
	Total	732*

**Note, more than one answer was provided by several respondents.*

12c. Mile marker(s) of favorite location?



Value	Percent	Count
H area	21.5%	92
1-3	18.0%	77
4-6	8.0%	34
7-9	19.4%	83
10-13	6.6%	28
J area	10.3%	44
14-17	8.7%	37
18-21	4.9%	21
22-24	1.6%	7
25-28	0.9%	4
	Total	**427**

13a. Are there locations on this lake that you deliberately avoid?

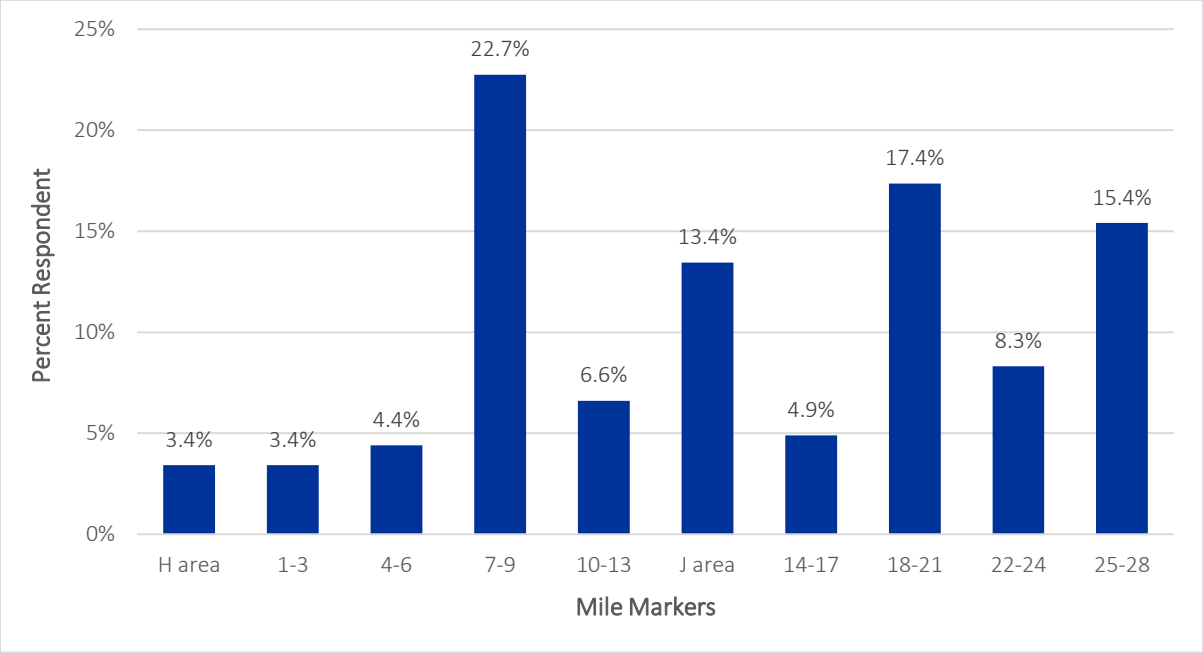
Value	Percent	Count
Yes	42.5%	287
No	57.5%	388
	Total	675

Nonresponse = 2

13b. Why do you avoid that/those locations(s)?

Value	Percent	Count
Crowded/Heavy boat traffic	37.2%	153
Narrow/Shallow	13.4%	55
Dirty/Debris/Water quality	11.4%	47
Rough/Choppy water	10.2%	42
Speed/Driving behavior of other boaters	9.0%	37
Too noisy/Partying	4.1%	17
Dangerous/Unsafe	2.7%	11
Too many jet skis	2.7%	11
Poor experience in area previously due to behavior of others	2.2%	9
Too many big boats	1.9%	8
Not child or family appropriate setting/Unsafe for kids	1.5%	6
BUI/Alcohol consumption	1.5%	6
Too many no-wake areas	1.5%	6
Distance from marina/boat launch	0.5%	2
Lack of no-wake areas	0.2%	1
	Total	**411**

13c. Mile marker(s) of the location(s) you avoid?



Value	Percent	Count
H area	3.4%	14
1-3	3.4%	14
4-6	4.4%	18
7-9	22.7%	93
10-13	6.6%	27
J area	13.4%	55
14-17	4.9%	20
18-21	17.4%	71
22-24	8.3%	34
25-28	15.4%	63
	Total	**409**

14a. Are there any locations on this lake where you feel unsafe?

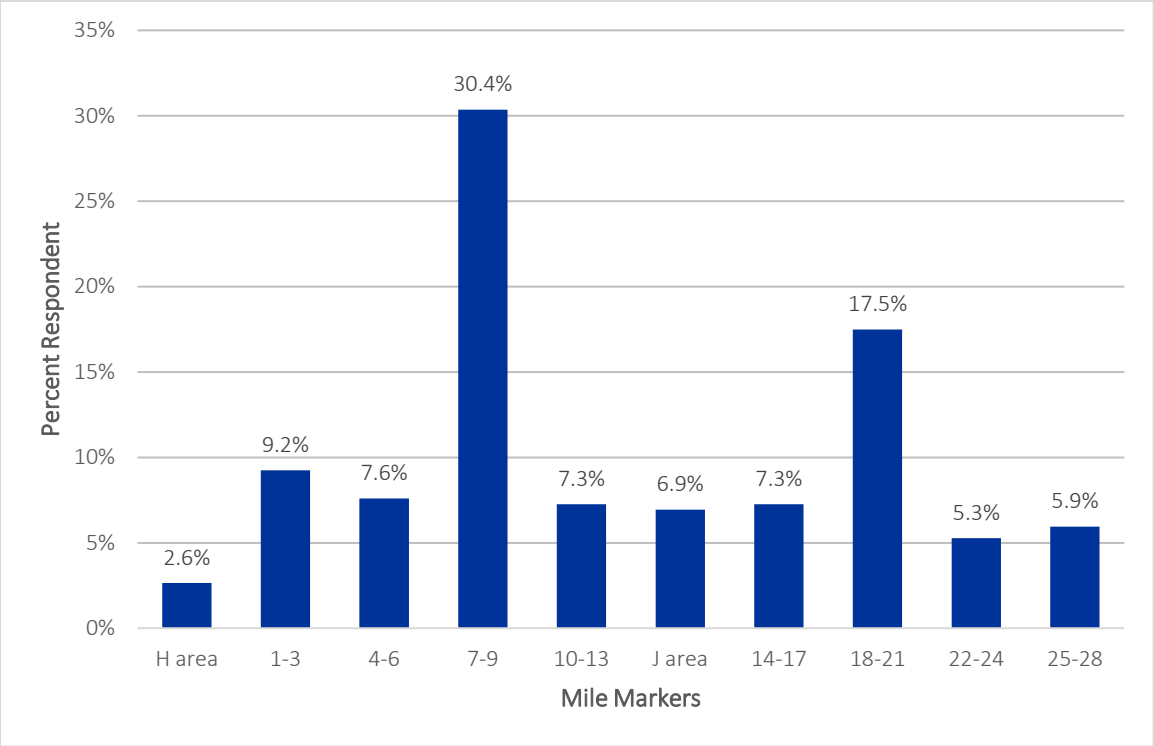
Value	Percent	Count
Yes	27.0%	182
No	73.0%	492
	Total	674

Nonresponse = 3

14b. Why do you feel unsafe at that/those location(s)?

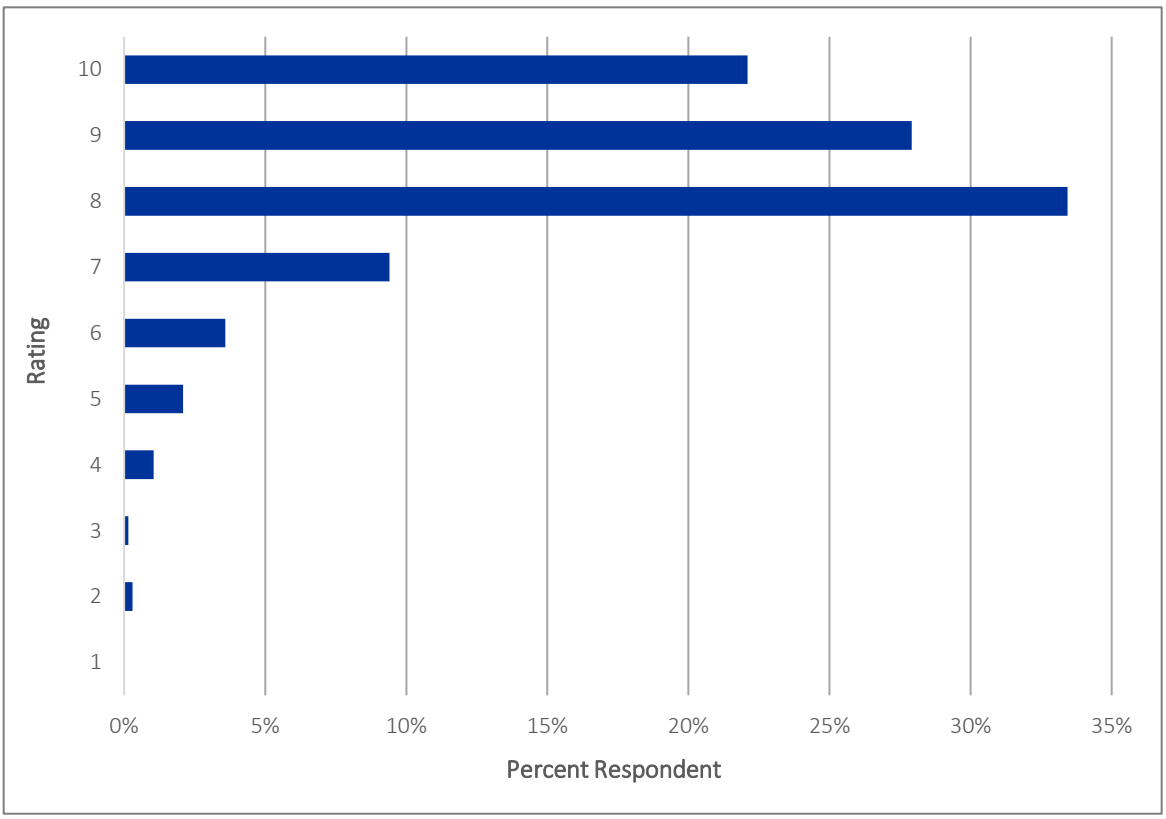
Value	Percent	Count
Crowded/Heavy boat traffic	31.6%	90
Speed/driving behavior of other boats	29.8%	85
Rough/Choppy water	10.9%	31
Narrow/Shallow	9.5%	27
Dirty/Debris/Water quality	4.9%	14
Big boats	4.9%	14
Too many jetskis	2.8%	8
Dangerous/unsafe	2.5%	7
BUI/Alcohol consumption by other boaters	1.8%	5
Lack of no-wake areas	0.7%	2
Unfamiliar with area	0.7%	2
	Total	**285**

14c. Mile marker(s) of the location(s) you feel unsafe?



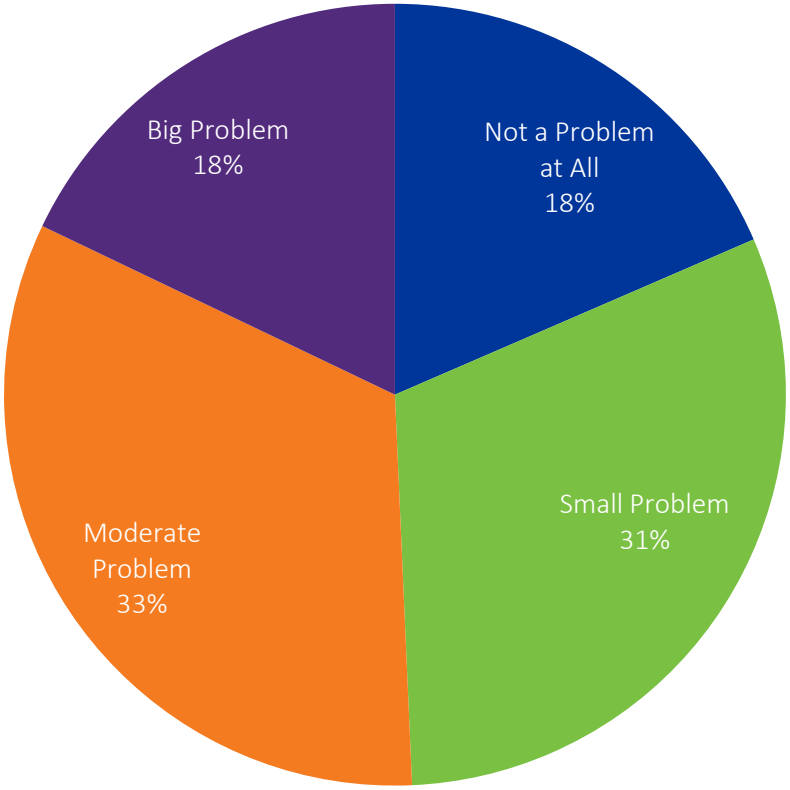
Value	Percent	Count
H area	2.6%	8
1-3	9.2%	28
4-6	7.6%	23
7-9	30.4%	92
10-13	7.3%	22
J area	6.9%	21
14-17	7.3%	22
18-21	17.5%	53
22-24	5.3%	16
25-28	5.9%	18
	Total	**303**

15. On a scale of 1 to 10 (with 10 being the perfect trip), how would you generally rate the quality of your boating experience at Raystown Lake?



Nonresponse = 7

16. How much of a problem is there from too many boats on the lake?



Value	Percent	Count
Not a Problem at All	18.5%	124
Small Problem	30.8%	207
Moderate Problem	32.8%	220
Big Problem	17.9%	120
	Total	**671**

Nonresponse = 6

17. How safe do you generally feel while boating or launching your boat at the following locations?

Location	Not at all safe		Somewhat safe		Moderately safe		Extremely safe		Not Applicable		Responses
	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	
At the boat ramp	1.6%	10	8.7%	55	25.9%	163	37.3%	235	26.5%	167	630
On the water	1.6%	10	12.9%	80	45.0%	280	37.6%	234	2.9%	18	622
At the marina	1.9%	12	5.5%	35	20.6%	131	58.4%	372	13.7%	87	637

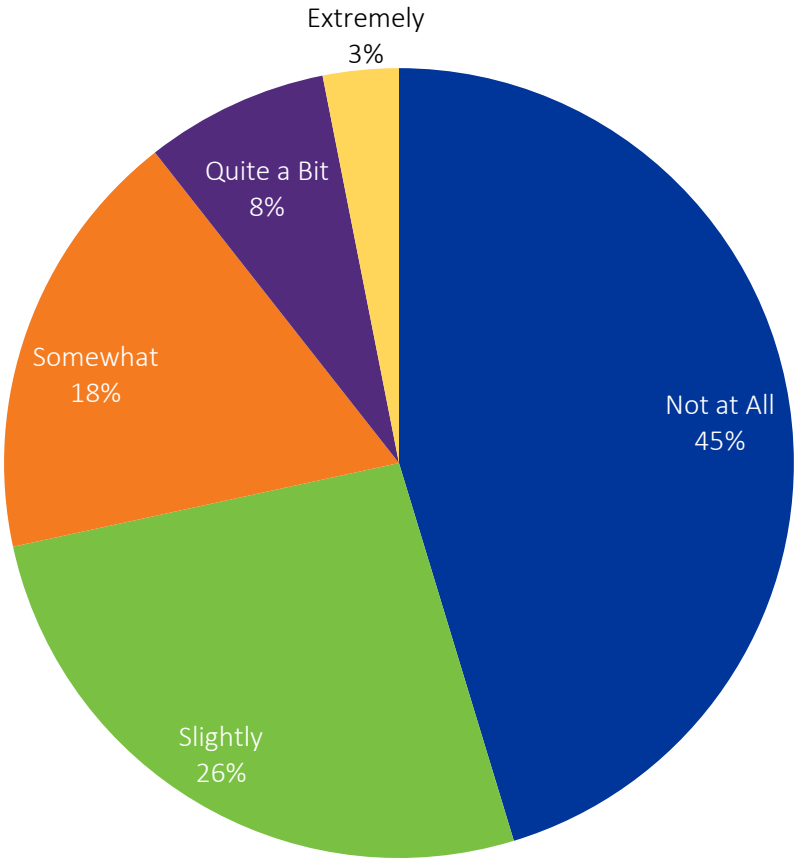
Nonresponse = 47; 55; 40

18. How crowded do you generally feel at the following locations?

Location	Not at all crowded		Somewhat crowded		Moderately crowded		Extremely crowded		Not Applicable		Responses
	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	
At the boat ramp	6.4%	42	17.0%	111	29.1%	190	20.8%	136	26.6%	174	653
On the water	17.3%	108	29.6%	185	37.8%	236	13.0%	81	2.4%	15	625
At the marina	23.1%	145	27.7%	174	26.9%	169	7.5%	47	14.9%	94	629

Nonresponse = 24; 52; 48

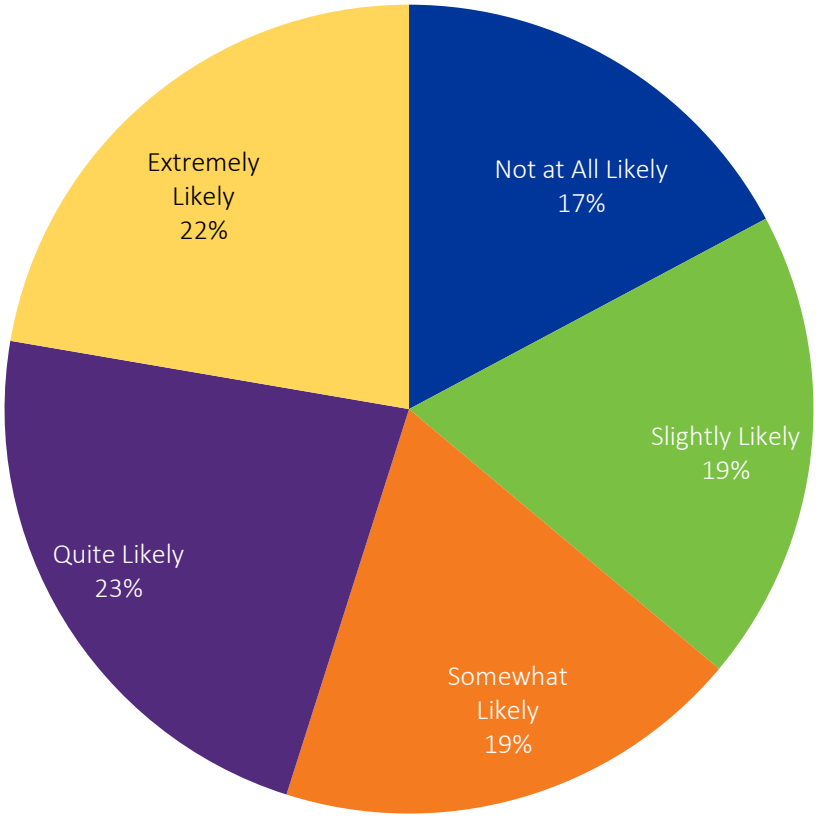
19. How much, if at all, has the noise from other boats reduced your enjoyment of Raystown Lake?



Value	Percent	Count
Not at All	45.3%	306
Slightly	26.3%	178
Somewhat	17.8%	120
Quite a Bit	7.5%	51
Extremely	3.1%	21
	Total	**676**

Nonresponse = 1

20. How likely is it that the presence of too many boats would cause you to avoid your favorite parts of Raystown Lake?



Value	Percent	Count
Not at All likely	17.2%	116
Slightly Likely	18.9%	128
Somewhat Likely	18.8%	127
Quite Likely	22.8%	154
Extremely Likely	22.3%	151
	Total	**676**

Nonresponse = 1

21. For each of the following, do you feel that at Raystown Lake there are too few, adequate, too many, or don't know?

	Too Few		Adequate		Too Many		Don't Know		Responses
	Row %	Count	Row %	Count	Row %	Count	Row %	Count	
Boat Ramps	27.5%	184	62.9%	420	0.7%	5	8.8%	59	668
Parking Areas	43.6%	292	51.3%	344	0.6%	4	4.5%	30	670
Waterways Conservation Officers	24.3%	162	60.7%	404	4.7%	31	10.4%	69	666
Park Rangers	17.4%	116	67.4%	450	2.1%	14	13.2%	88	668
Marinas	20.6%	137	70.9%	471	4.5%	30	3.9%	26	664

Nonresponse = 9; 7; 11; 9; 13

22. Have you noticed any positive or negative changes at this lake in the last five years?

If you have, please describe the changes.

Positive Change	Percent	Count
Hiking/ walking trail	15.2%	54
Bike trail	9.8%	35
Marina Improvements	9.8%	35
Facility Improvements	8.1%	29
Cleaner	6.5%	23
New Mile Markers	6.5%	23
Campsite Improvements	6.2%	22
Removal of launch or parking fees	6.2%	22
Increased law enforcement/ ranger presence	4.5%	16
Improvements to fish or wildlife population	3.7%	13
Good management	3.7%	13
Well maintained	3.4%	12
More parking	3.1%	11
Reduction of no-wake zones	2.2%	8
Sense of community	2.2%	8
Erosion control/ management	2.0%	7
Less boats	1.7%	6
Minimal Development	1.7%	6
More no-wake zones	1.4%	5
Free life jacket program	1.1%	4
More recreation opportunities	1.1%	4
	Total	356

Nonresponse = 1 (all others did not notice any negative or positive changes)

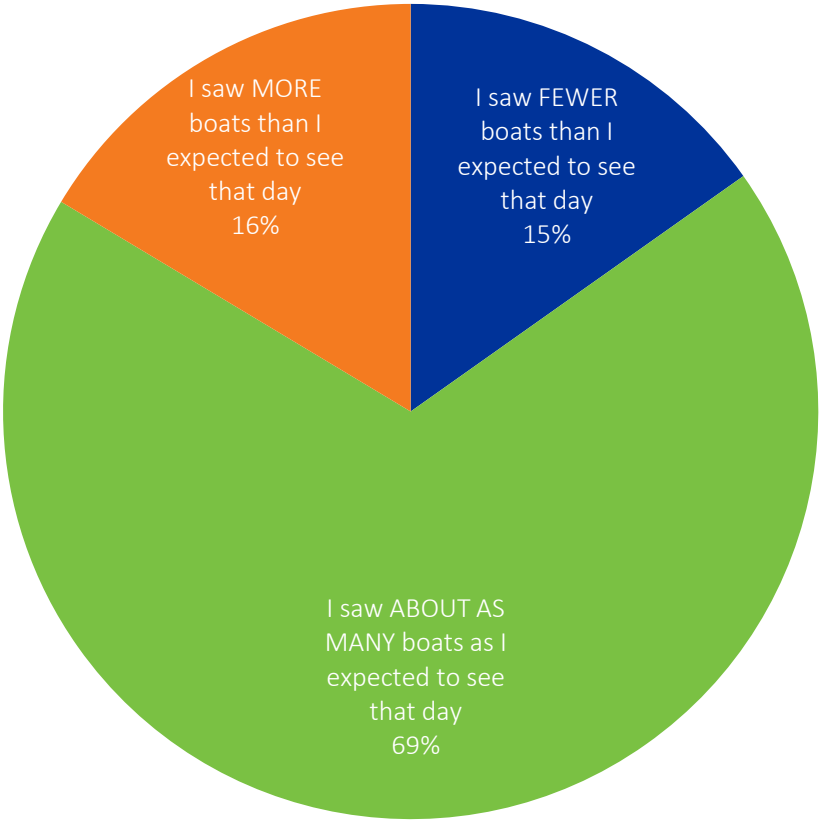
Negative Change	Percent	Count
Generally too crowded	17.6%	81
Unsafe behavior of other boaters	10.9%	50
Poor water quality/debris /trash	10.4%	48
Lack/decline of facilities or services	9.8%	45
Weekend/holiday crowding	5.7%	26
Lack of parking	5.7%	26
Lack of law enforcement	5.0%	23
Removal or addition of no-wake zones	5.0%	23
Too many big boats	4.6%	21
Poor fishing/environmental degradation/loss of natural beauty	4.3%	20
Too crowded at boat ramp	3.9%	18
Behavior of other park/lake visitors	3.5%	16
Campgrounds are full/hard to get	3.3%	15
Pipeline project	3.0%	14
Too many PWC	3.0%	14
Rude management and/or staff	2.0%	9
Unsafe	1.1%	5
Increase in out-of-state boaters	0.9%	4
Marina slips are hard to get / unavailable	0.4%	2
	Total	**460**

22. If you have noticed changes, how have these changes affected your enjoyment or use of Raystown Lake?

Positive Change Affect	Percent	Count
More enjoyable experience	41.5%	68
Safer/more at ease	15.2%	25
More recreation activities and opportunities	7.9%	13
Maintains natural beauty/ peace	7.9%	13
Visit more often	7.3%	12
Easier navigation	6.1%	10
Increased usage of certain facilities	4.9%	8
More family friendly	2.4%	4
More area to anchor/tie up/dock boat	2.4%	4
Fishing is better/more wildlife	2.4%	4
Cleaner	1.8%	3
	Total	**164**

Negative Change Affect	Percent	Count
Changing time of visit to avoid crowding	25.1%	55
Visit less often	7.8%	17
Avoid certain areas	5.0%	11
Not as relaxing/enjoyable experience	27.4%	60
Limit activities participated in	6.8%	15
Feel less safe	19.2%	42
Less fishing/enjoying nature	8.7%	19
	Total	**219**

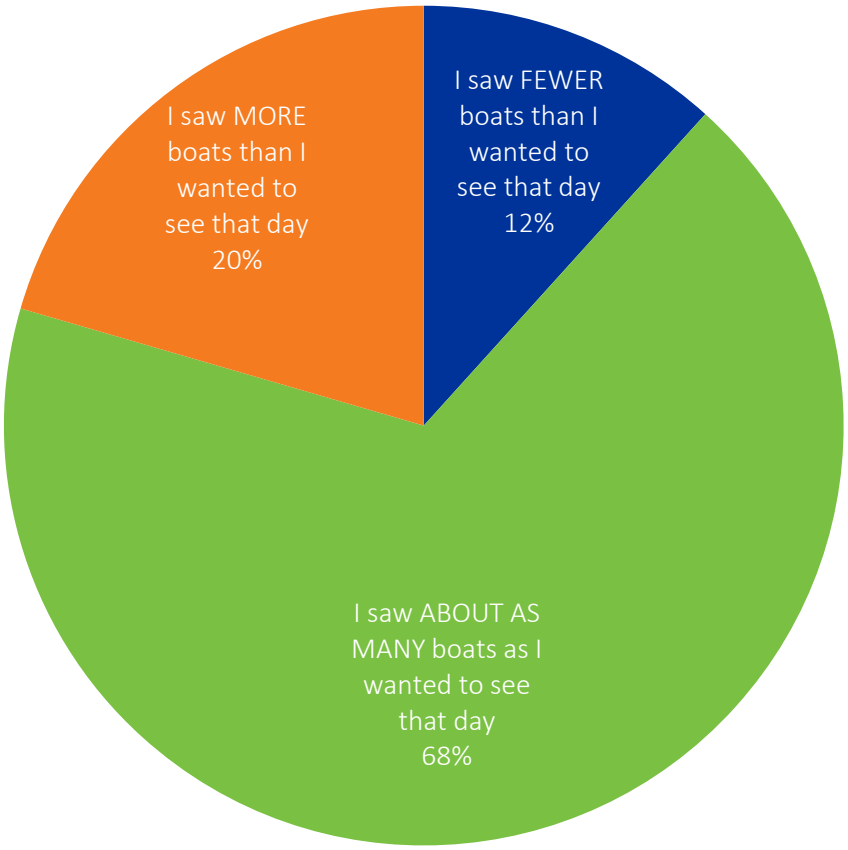
23. Which of these statements best describes your expectation for the number of boats on Raystown Lake? Please refer to your last outing on the lake when answering this question.



Value	Percent	Count
I saw FEWER boats than I expected to see that day	15.2%	102
I saw ABOUT AS MANY boats as I expected to see that day	68.4%	459
I saw MORE boats than I expected to see that day	16.4%	110
	Total	671

Nonresponse = 6

24. Which of these statements best describes your preference for the number of boats on Raystown Lake? Please refer to your last outing on the lake when answering this question.



Value	Percent	Count
I saw FEWER boats than I wanted to see that day	11.7%	78
I saw ABOUT AS MANY boats as I wanted to see that day	67.8%	452
I saw MORE boats than I wanted to see that day	20.5%	137
	Total	667

Nonresponse = 10

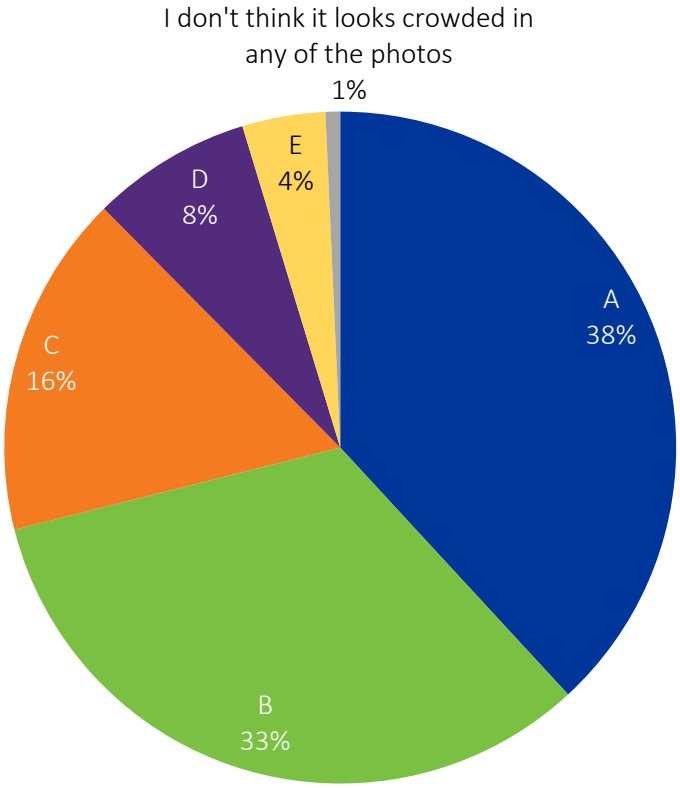
25. To what extent do you agree or disagree with each of the following statements?

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Responses
	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	
I generally stay off the lake during parts of the day/week because of too many boats on the lake	28.3%	185	26.6%	174	17.3%	113	19.1%	125	8.7%	57	654
My boating trips are generally not as enjoyable as I expect them to be	2.3%	15	9.0%	58	16.5%	106	47.6%	306	24.6%	158	643
There are generally an unsafe number of boats on the water	7.4%	48	18.6%	121	27.3%	177	34.7%	225	12.0%	78	649
Other boats generally come closer to my boat than I like	16.6%	108	24.2%	158	21.0%	137	29.1%	190	9.0%	59	652
My boat trip(s) are generally well worth the money I spend to take them	23.8%	155	54.1%	352	15.4%	100	5.4%	35	1.4%	9	651
The behavior of other boaters generally interfered with the quality of my boating experience	11.0%	71	22.0%	142	26.3%	170	31.6%	204	9.1%	59	646
I generally do not like the amount of time I have to wait to get on the water	5.0%	32	14.8%	94	36.9%	234	28.3%	180	15.0%	95	635
Boating conditions on the lake are generally safe	12.1%	78	55.3%	358	19.0%	123	12.4%	80	1.2%	8	647
All boaters should be required to wear a Personal Floatation Device (PFD) while boating	6.6%	43	9.1%	59	19.8%	128	34.9%	226	29.5%	191	647
I generally do not participate in some boating activities because of crowded conditions at the lake	16.8%	110	27.8%	182	16.4%	107	28.3%	185	10.7%	70	654

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Responses
	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	
The size of the boats that I generally see on Raystown Lake is acceptable in terms of my experience	13.3%	85	55.1%	353	17.2%	110	11.2%	72	3.3%	21	641
The speed used by other boaters is generally safe	6.9%	44	46.6%	299	24.8%	159	16.5%	106	5.1%	33	641

Nonresponse = 23-42

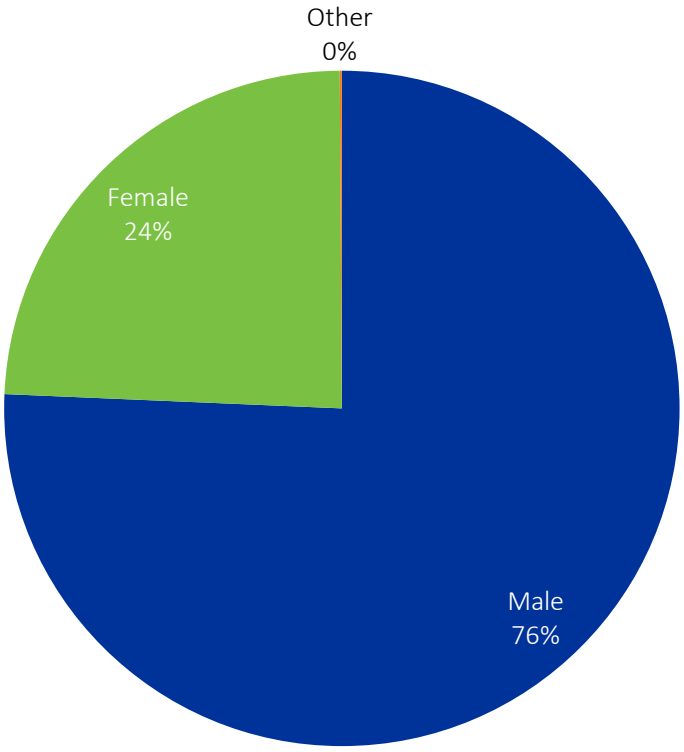
26. Which photo shows the maximum number of boats you could see at one time on Raystown Lake WITHOUT thinking it was crowded?



Value (acres/boat)	Percent	Count
A (20)	38.1%	256
B (12.5)	32.9%	221
C (10)	16.5%	111
D (8.3)	7.7%	52
E (6.7)	4.0%	27
I don't think it looks crowded in any of the photos	0.7%	5
	Total	672

Nonresponse = 5

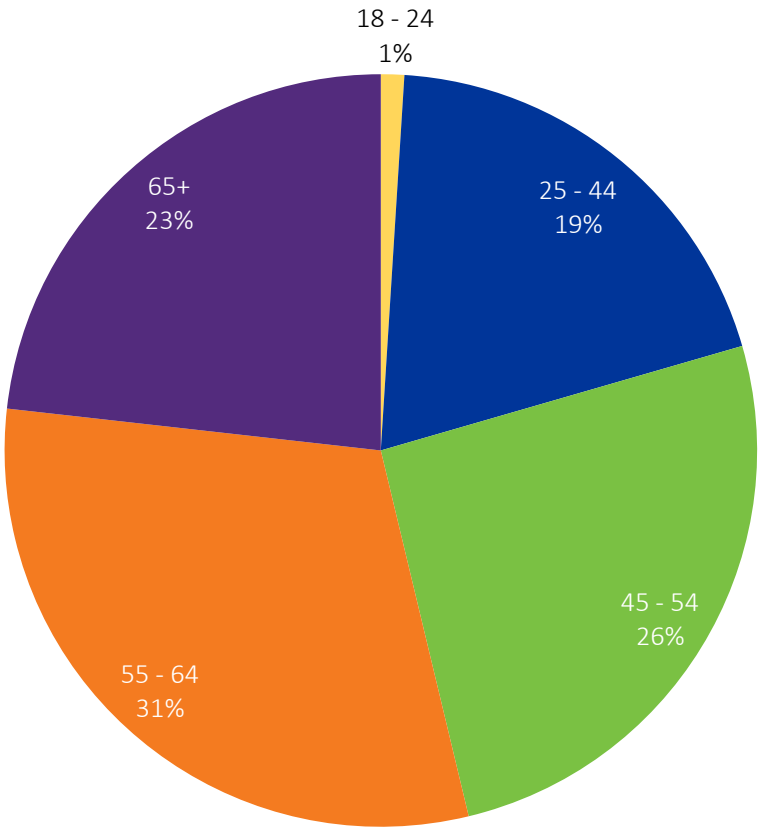
27. What is your gender?



Value	Percent	Count
Male	75.6%	509
Female	24.2%	163
Other	0.1%	1
	Total	**673**

Nonresponse = 4

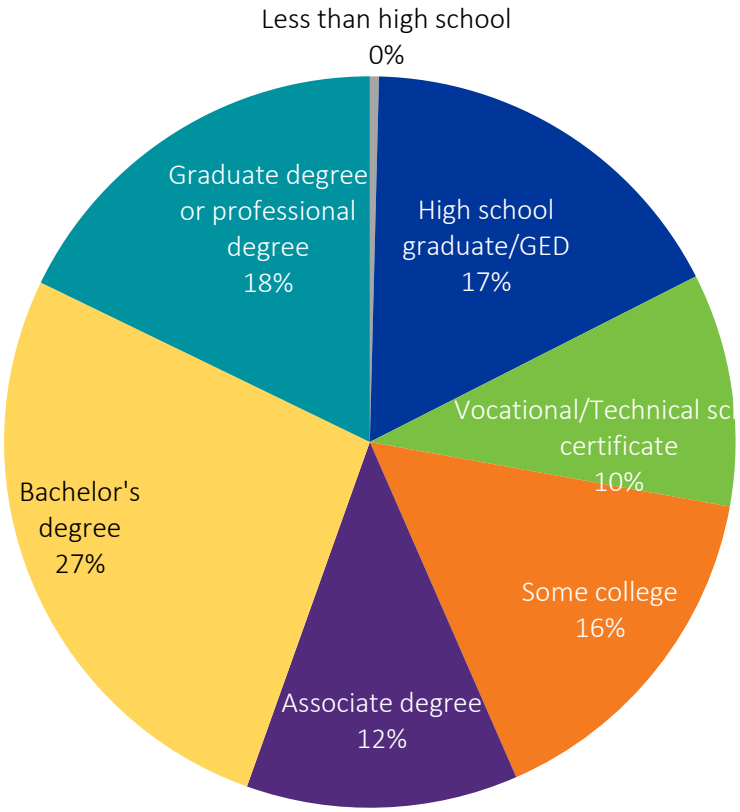
28. What is your age?



Value	Percent	Count
18 - 24	1.0%	7
25 - 44	19.5%	131
45 - 54	25.7%	173
55 - 64	30.5%	205
65+	23.2%	156
	Total	672

Nonresponse = 5

29. What is the highest level of education you have completed?



Value	Percent	Count
Less than high school	0.4%	3
High school graduate/GED	17.1%	114
Vocational or Technical school certificate	10.3%	69
Some college	15.6%	104
Associate degree	12.0%	80
Bachelor's degree	26.7%	178
Graduate degree or professional degree (MA, MS, PhD, JD, MBA, etc.)	17.8%	119
	Total	667

Nonresponse = 1

A.4 User Survey Discussion and Limitations

The original survey sampling method had to be adjusted due to external factors. The initial number of public ramp users signed up through the on-site canvas was lower than anticipated. Therefore, the USACE information on campers was utilized to invite more potential respondents for the survey. There was a significantly higher response rate among marina users than among those solicited from the registration database and camper list. In addition, there were camper respondents who were not boaters, thus requiring a second solicitation from the camper registration list to achieve the target sample size for public ramp users. A poststratification of the marina user subpopulation responses was required to reduce oversampling bias. A minimum sample size for statistical significance was achieved with a proportional balance between marina users and public ramp users.

Due to the schedule of survey approval, the survey was administered several months after the summer boating season concluded. The lapse in time may have impacted the number of respondents willing to complete the survey. Research indicates that general experiences and boating takeaways can be recalled with sufficient accuracy even after the amount of time had passed. However, Question 23 asked the respondent to indicate the date of their last outing and provide experiences based on that outing. Some of the respondents indicated that they had been boating as recently as October or November when boating conditions were not as crowded when compared to summer boating.

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Appendix B
WALROS Protocol and Worksheet

This document contains background information, guidance, and instructions on how to complete the Water and Land Recreation Opportunity Spectrum (WALROS) assessment for Raystown Lake. It also includes the WARLOS assessment worksheets, which will be utilized by CDM Smith for establishing a recommended boating carrying capacity range for each study zone and the entire lake. **While USACE Project Office staff will complete the survey, CDM Smith experts will be responsible for finalizing all scoring and generating the classification for Raystown Lake.**

Please have a minimum of five Project Office staff members complete this assessment. We recommend utilizing ranger staff familiar with the entire lake during peak usage.

WALROS is a tool developed by the U.S. Bureau of Reclamation (Reclamation) to understand the type and location of six types of water-related recreation opportunities, otherwise known as WALROS classes. The six WALROS classes range across a spectrum of urban, suburban, rural developed, rural natural, semi primitive, and primitive recreation opportunities. A particular "package" of activities, setting attributes, experiences, and benefits, defines each WALROS class and therefore established recommended ranges of boating density based on the lake's WALROS classification. Much of the information contained within this packet was taken from Reclamation's WALROS User's Handbook, Second Edition, September 2011.

WALROS enables an inventory of mapping of the six recreation opportunities by using expert opinion. CDM Smith is looking to the Raystown Lake Project Office staff to assess the physical, managerial, and social attributes of the lake setting so that a WALROS classification can be established. **Table 1-1** illustrates the attributes that differentiate the six WALROS classes

Table 1-1. WALROS Class Attributes

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

The overarching goal of WALROS is to provide planners and managers with a framework and procedure for making better decisions in order to conserve a spectrum of high-quality and diverse water and land recreation opportunities. WALROS improves our understanding of the complexity of

outdoor recreation management, strengthens sound professional judgment, and enables a manager to make better and more defensible decisions.

B.1 Reasonable Flat-Water Recreation Boating Coefficients

To help managers, a set of boating capacity coefficients has been developed by Reclamation based on collaborative expert opinion, professional experience, published articles and plans, sound professional judgment, and the rule of reasonableness. The boating coefficients range from 1 to 3,200 acres per boat depending on the WALROS classification. For each of the six WALROS classifications on the spectrum from urban to primitive, there are six integrated packages containing appropriate settings, activities, and experiences. The results of this analysis for the Raystown Lake Recreational Carrying Capacity will be one component in the characterization and final recommended capacity range of Raystown Lake.

B.2 WARLOS Classification Descriptions

Figure 1-2 through **Figure 1-7** show examples of boating recreation activities and setting attributes by WALROS class, along with a description of the recreation experiences each class offers, as provided by the Bureau of Reclamation WALROS Handbook, Second Edition (2011).

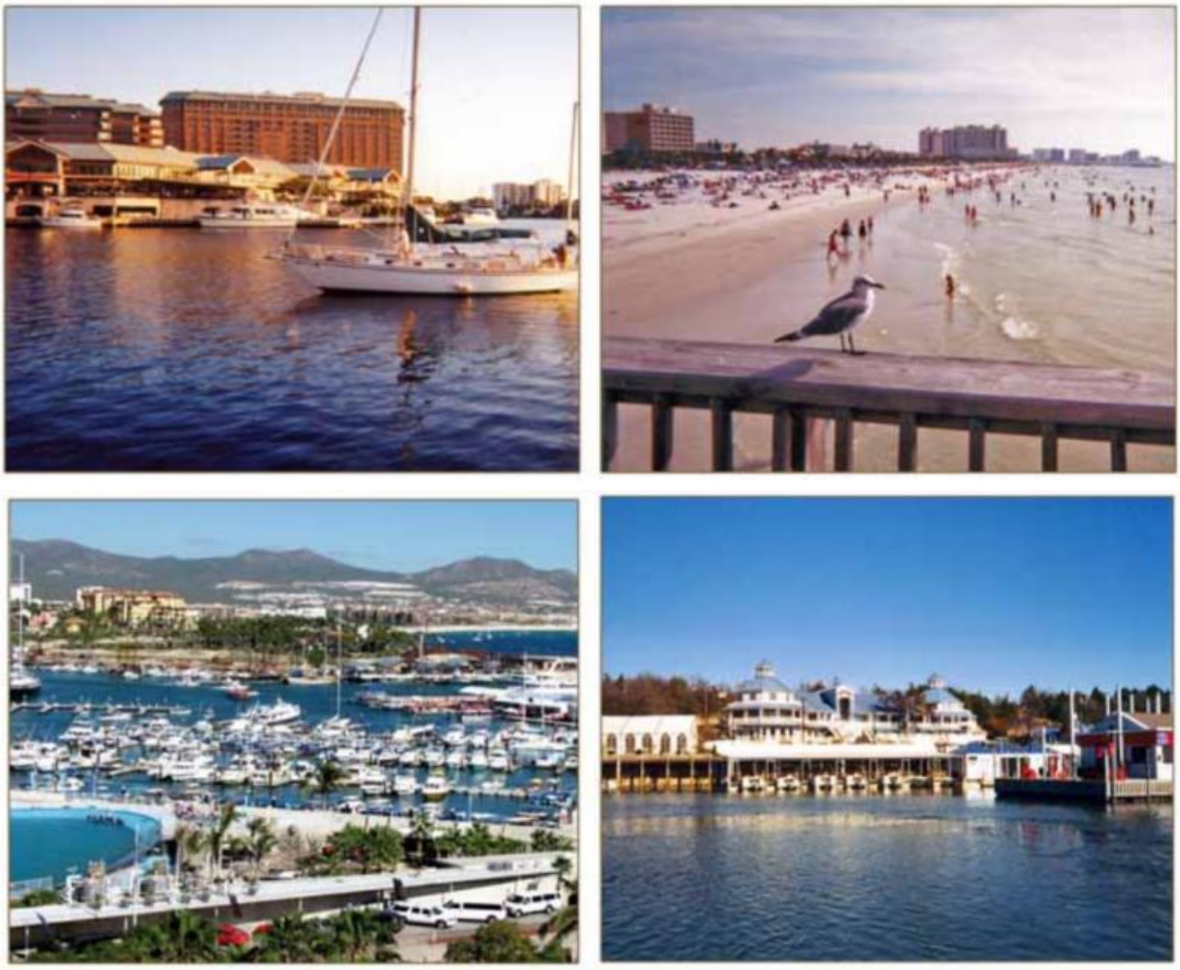

Figure 1-2
Examples of the Urban Classification

Urban recreation experience: The area provides very limited opportunities to see, hear, or smell the natural resources (e.g., forests, wildlife, aesthetics) because of the extensive level of development, human activity, and natural resource modification. Watching and meeting other visitors is expected and desired, while large group activities such as guided fishing, tour boat sightseeing, and beach sports are popular. There may be opportunities to briefly relieve stress and alter everyday routines. Socializing with large groups, family, and friends is important. In addition, a high sense of safety, security, comfort, and convenience is central and dominant. The mix of recreation activities may be diverse, ranging from those of relaxation and contemplation (e.g., sunbathing, reading, nature walking) to physical exertion. Thrills, excitement, and challenge (e.g., parasailing, jet boating, water skiing) are often attractive to short-time visitors, large affinity groups, tourists, and school groups. The area may serve as a transportation corridor for transient visitors or as a staging area for others traveling to nonurban settings. Thus, the urban area is popular with local residents and with nonresident first-time tourists.

Figure 1-3
Examples of the Suburban Classification

Suburban recreation experience: The area provides little opportunity to see, hear, or smell the natural resources (e.g., forests, wildlife, aesthetics) because of the widespread and prevalent level of development, human activity, and natural resource modification. Moreover, watching and meeting other visitors is expected and desired. The area provides an opportunity to briefly relieve stress and alter everyday routines. Socializing with family and friends is also important since large groups and families are common. A high sense of safety, security, comfort, and convenience is central and dominant. The mix of recreational activities may be diverse, ranging from relations and contemplation (e.g., sunbathing, reading, and nature walking) to physical exertion, thrills, excitement, and challenge (e.g., parasailing, jetboating, and water skiing). Learning about natural or cultural history, ecology, and reservoir and river operations is important to some people. Thus, the suburban area is a popular attraction to many local residents.

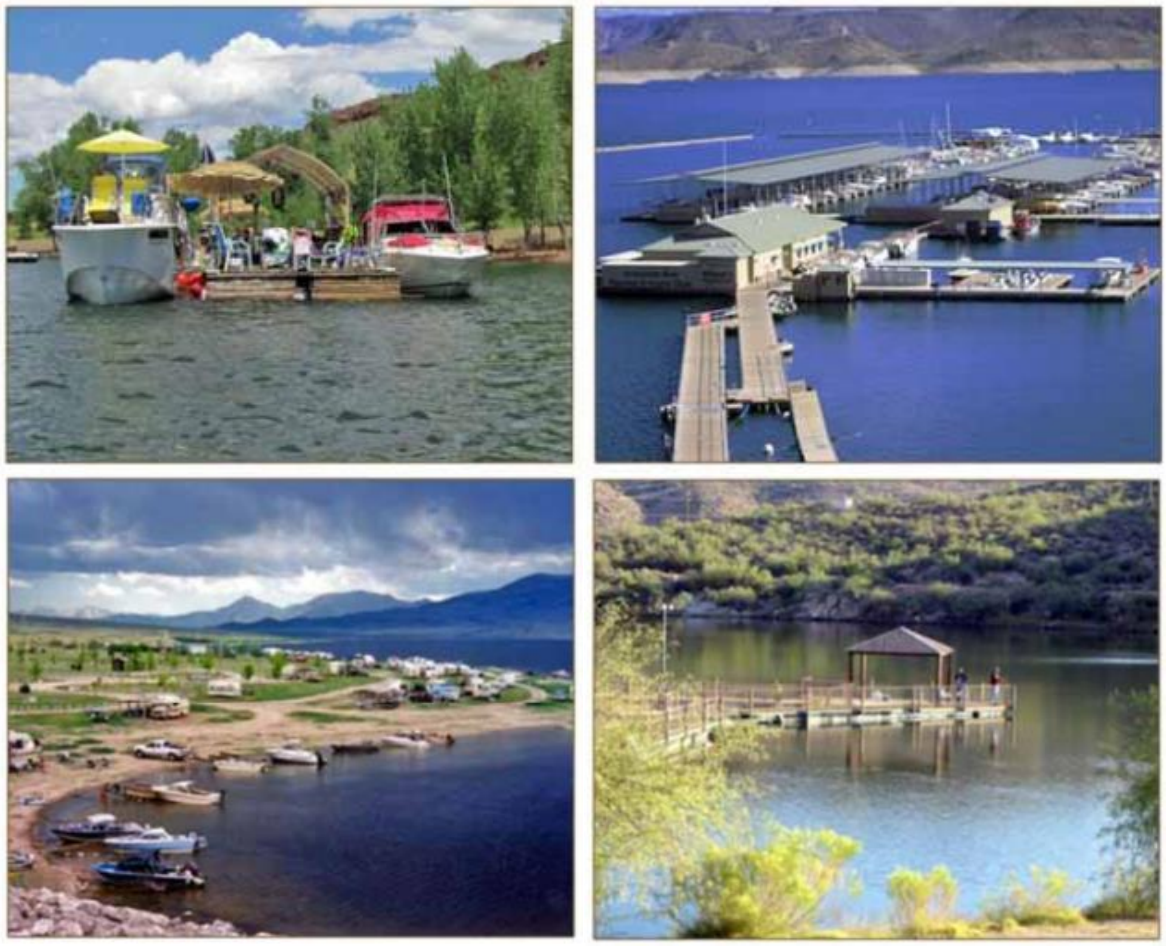

Figure 1-4
Examples of the Rural Developed Classification

Rural developed recreation experience: The area provides occasional or periodic opportunities to see, hear, or smell the natural resources (e.g., forests, wildlife, aesthetics), but development, human activity, and natural resource modifications are common and frequently encountered. The area is less developed and more tranquil than a suburban setting. The opportunity to experience brief periods of solitude is important but changes from day to day. In a rural developed area, everyday sights and sounds are also important. Socialization within and outside one's group is typical, and the presence of other visitors is expected. The opportunity to relieve stress, alter everyday routines, and achieve a moderate level of comfort and convenience along with a sense of safety and security is important. The array of recreation activities may be diverse, ranging from relaxation and contemplation (e.g., sunbathing, sail boating, shoreline fishing) to physical exertion and challenge (e.g., competing in shoreline and water sports, tournament fishing, ice fishing, water skiing, snowmobiling, motocross racing, and kayaking). The rural developed area is typically attractive for day use by weekend visitors from local metropolitan areas, nearby communities, short-term campers, recreational vehicle users, large groups, and adventure tourists with a day's drive.

Figure 1-5
Examples of the Rural Natural Classification

Rural natural recreation experience: The area provides frequent opportunities to see, hear, or smell the natural resources (e.g., forests, wildlife, aesthetics), as development, human activity, and natural resource modifications are only occasional and infrequent. It is noticeably more natural, less developed, and more tranquil than an urban setting. Socialization with other outside one's group is not very important, although the presence of others is expected and tolerated. The opportunity to relieve stress and get away from an infrastructure environment is important; a high sense of safety, security, comfort, and convenience is not important or expected. Moreover, a sense of independence, freedom, moments of solitude, tranquility, and the appreciation of nature are also important. Various experiences tend to be more resource dependent, diverse, and may include relations and contemplation. Such activities include camping, sunbathing, canoeing, sailing, and boat fishing. Other activities involve socialization and physical exertion (e.g., competitive tournament fishing, kayaking, water skiing, hunting, and float boat fishing). The rural natural area is typically attractive to extended weekend and long-term visitors who desire to experience the outdoors and get way from large numbers of other people. The rural natural area is popular with overnight visitors using recreational vehicles, tents, and rustic cabins.

Figure 1-6
Examples of the Semi Primitive Classification

Semi-primitive recreation experience: The area provides widespread and prevalent opportunities to see, hear, or smell the natural resources (e.g., forests, wildlife, and aesthetics) since development, human activity, and natural resource modifications are seldom encountered. The opportunity to experience a natural ecosystem with little human imprint, a sense of challenge, an adventure, a risk, a sense of self-reliance, and a feeling of solitude are all important characteristics. However, management is important on the water and at destination sites even though the recreation experiences tend to be more resource based. A sense of independence, freedom, tranquility, relaxation, appreciation of nature, testing skills, and stewardship is typical. The opportunity often requires more trip planning, preparation, travel distance of one or more days, physical effort, and duration. The semi-primitive area provides opportunities for the more adventure-based enthusiasts (e.g., fly and float fishing, hunting, backcountry camping, canoeing, rafting, and nature viewing). Overnight visits typically involve tents in settings with few conveniences and facilities, although extended stays may be accommodated. Adventure recreationists and ecotourists are attracted to this setting. However, inexperienced recreationalists or visitors new to the area may be uncomfortable with the remoteness and the necessary requirement of self-reliance.

Figure 1-7
Examples of the Primitive Classification

Primitive recreation experience: The area provides opportunities to see, hear, or smell the natural resources (e.g., forests, wildlife, and aesthetics) since development, human activity, and natural resource modifications are rare. The opportunity to experience natural ecosystems with very little and no apparent human imprint is paramount. The natural views, sounds, and smells dominate the area. A sense of solitude, peacefulness, tranquility, challenge, adventure, risk, and self-reliance is highly important, as is the lack of sight, sounds, and smells of other humans. A sense of freedom, tranquility, humility, relaxation, appreciation of nature, and stewardship is central and dominant. The primitive recreation experience provides opportunities for human-powered activities such as canoeing, kayaking, fly-fishing, hunting, floating, and backpacking. The high-speed noise of motorized conveyances is typically inappropriate for this area. Visitation often requires considerable trip planning and preparation, travel distance, physical exertion, and duration. Overnight visitors use tents in settings with no conveniences or facilities. Adventure travelers and ecotourists from distant locations are often attracted to the undisturbed wildland setting.

B.3 Raystown Lake Inventory

This inventory protocol for Raystown Lake is intended to be completed by the Raystown Lake Project Office staff. As discussed in Section 1, the inventory is broken down by physical, social, and managerial attributes that affect the quality or nature of a recreation experience. This assessment should be completed for each of the Raystown Lake study zones, as shown in **Figure 2-1**. The time period under consideration in this assessment should be weekends during peak boating season.

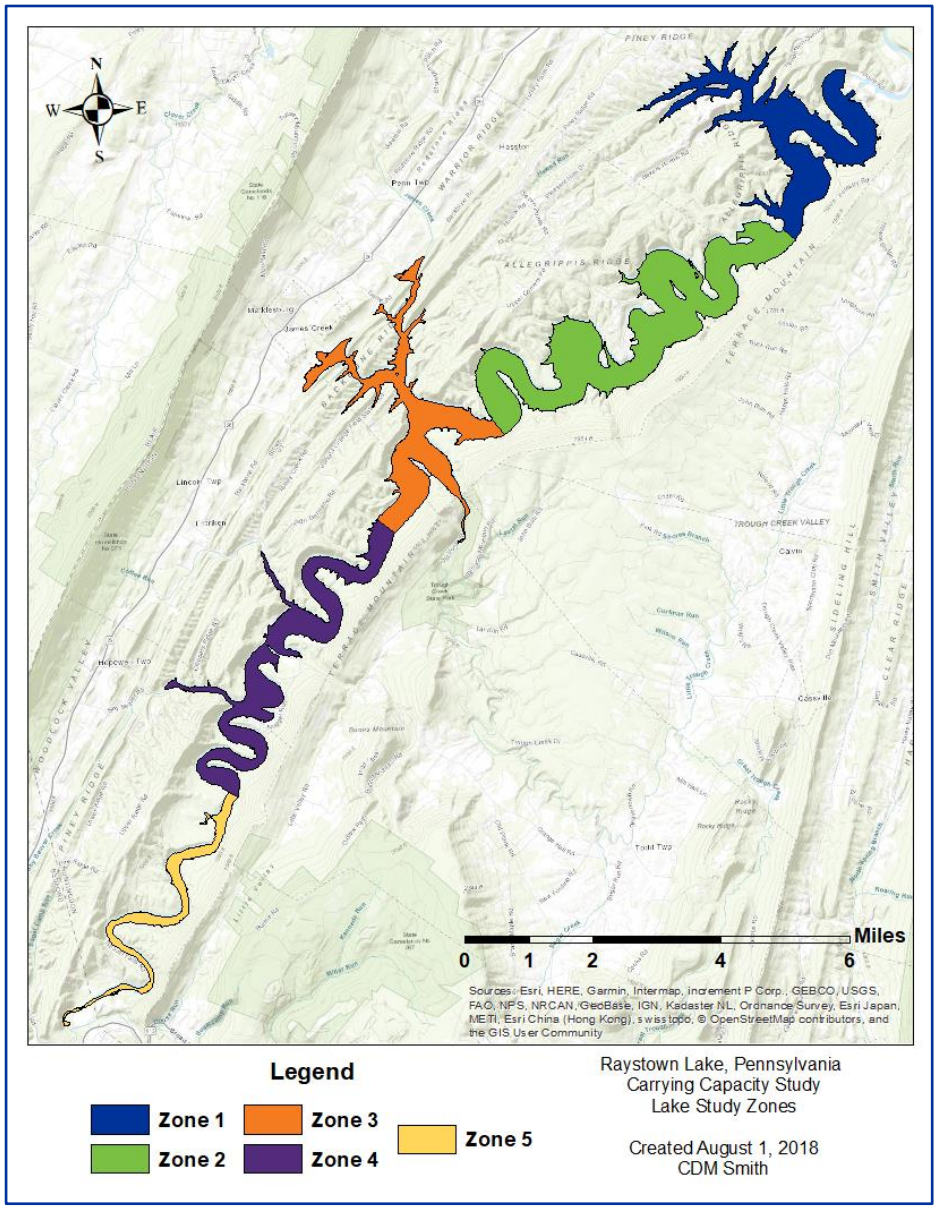

Figure 2-1
Raystown Lake Study Zones

Within each attribute section, some questions are aimed at estimating distances to facilities and services. In order to assist with this portion of the assessment, a desktop analysis was completed by

CDM Smith using GIS. **Tables 2-1** through **2-3** provide a summary of the information collected during that analysis. This is provided to support the Project Office staff in assessing the characteristics of the lake and should be used as reference when completing the questions that follow.

Table 2-1. Results of desktop analysis regarding distances to physical facilities and services

Physical Inventory												
Lake Study Zone	Dams			Bridges			Marinas			Towns		
	Furthest Point (mi)	Closest Point (mi)	Average (mi)	Furthest Point (mi)	Closest Point (mi)	Average (mi)	Furthest Point (mi)	Closest Point (mi)	Average (mi)	Furthest Point (mi)	Closest Point (mi)	Average (mi)
1	3.2	0	1.6	12.6	10.3	11.4	5.2	2.8	4	6	3	4.5
2	7.7	2.5	5.1	10.3	4.9	7.6	2.8	0	1.4	9.6	6	7.8
3	10	7.7	8.8	4.9	2.6	3.7	4.2	2.6	3.4	9.6	9.6	9.6
4	14.7	10	12.4	2.6	0	1.3	3.4	0	1.7	9.8	4.8	7.3
5	19.1	14.7	16.9	2.8	0	1.4	6	1.5	3.7	4.8	0.7	2.7

Table 2-2. Results of desktop analysis regarding distances to visitor services

Social Inventory									
Lake Study Zone	Project Office			Security/Safety			Comfort/Convenience		
	Furthest Point (mi)	Closest Point (mi)	Average (mi)	Furthest Point (mi)	Closest Point (mi)	Average (mi)	Furthest Point (mi)	Closest Point (mi)	Average (mi)
1	5.3	2.6	4	6	3	4.5	6	3	4.5
2	3.8	1.1	2.4	9.6	6	7.8	9.6	6	7.8
3	5	2.2	3.6	9.6	9.6	9.6	9.6	9.6	9.6
4	9.8	5	7.4	9.8	4.8	7.3	9.8	4.8	7.3
5	14.1	9.8	11.9	4.8	0.7	2.7	4.8	0.7	2.7

Table 2-3 Results of desktop analysis regarding distances to management facilities

Management Inventory						
Lake Study Zone	Developed Recreation Facilities			Developed Public Access Facilities		
	Furthest Point (mi)	Closest Point (mi)	Average (mi)	Furthest Point (mi)	Closest Point (mi)	Average (mi)
1	2.3	0	1.2	2.3	0	1.2
2	1.8	0	0.9	1.8	0	0.9
3	1.8	0	0.9	1.8	0	0.9
4	1.4	0	0.7	1.4	0	0.7
5	2.2	0	1.1	2.2	0	1.1

The remaining pages contain the inventory worksheets taken directly from the WALROS Handbook (2011). Please print and have a minimum of five project office staff individually complete the remainder of this document.

Question 1. Physical Inventory Protocol

Please complete each attribute section for each of the five lake study zones. Rows are provided under each inventory question with lake study zones. Please circle the lake study zone which applies to each category selected.

Physical Inventory Protocol Sheet						
Degree of development – Degree that dams, major bridges, marinas, parks, resorts, highways, or other municipal, residential, industrial, or commercial structures are present.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Sense of closeness to a community – Degree that visitor's sense that they are close to the sights, sounds, and smells typical of a community.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Degree of natural resource modification – Degree that the visitors are aware that human activity, technology, or development has altered the natural resources.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Distance from development on or adjacent to the water resource – Mileage from dams, major bridges, marinas, resorts, or other municipal, industrial, commercial, or residential areas.	Less than 0.5 miles	0.5-2 miles	2-5 miles	5-8 miles	8-10 miles	More than 10 miles
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Degree that natural ambiance dominates the area – Degree that there is a sense of tranquility and opportunity to see, hear, and smell nature.	Very minor, very little, or rare 0-3%	Minor, little, or seldom 3-10%	Occasional, infrequent, or periodic 10-20%	Prevalent, common, or apparent 20-50%	Very prevalent or widespread 50-80%	Extensive, dominant, or a great deal 80-100%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

After each attribute is checked or circled on the scale of degree, circle the number in the table below for each lake zone that best represents your overall judgement of the area. The odd numbers represent the six WALROS classes, while the even numbers represent the midpoint between two WALROS classes. This decision should be based on your sound professional judgment, preponderance of the evidence, and how the attributes were circled in the cells above. The descriptions provided in Section 1 of this document may be helpful. There is no formula or mathematical calculation to arrive at this overall judgment for the area.

	Physical Inventory WALROS Classification (circle number)										
	Urban		**Suburban**		**Rural Developed**		**Rural Natural**		**Semi-Primitive**		**Primitive**
LAKE ZONE 1	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 2	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 3	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 4	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 5	1	2	3 4		5 6		7 8		9	10	11

Question 2. Social Inventory Protocol

Please complete each attribute section for each of the five lake study zones. Rows are provided under each inventory question with lake study zones. Please circle the lake study zone which applies to each category selected.

Social Inventory Protocol Sheet						
Degree of visitor preference – Degree that the sights, sounds, and smells of other visitors, their equipment, their impacts, or litter are present.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Degree of visitor concentration – Degree that visitors congregate in the area (e.g., service area, launches, entrances, swim areas, trailheads, vistas, picnic or camp areas).	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Degree of recreation diversity – Degree that there is a mixture of recreation activities being participated in or equipment being used.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Distance to visitor's services, security, safety, comforts, and conveniences.	Less than 0.5 miles	0.5-2 miles	2-5 miles	5-8 miles	8-10 miles	More than 10 miles
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Degree of solitude and remoteness– Degree that visitors view themselves as being alone and far away from civilization, in a wild and remote place	Very minor, very little, or rare 0-3%	Minor, little, or seldom 3-10%	Occasional, infrequent, or periodic 10-20%	Prevalent, common, or apparent 20-50%	Very prevalent or widespread 50-80%	Extensive, dominant, or a great deal 80-100%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Degree non-recreational activity– Degree of sights, sounds, and smells of non-recreational activities (i.e., shipping, trains, factories, roads, houses, airplanes, mining, and farming).	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

After each attribute is checked or circled on the scale of degree, circle the number in the table below for each lake zone that best represents your overall judgement of the area. The odd numbers represent the six WALROS classes, while the even numbers represent the midpoint between two WALROS classes. This decision should be based on your sound professional judgment, preponderance of the evidence, and how the attributes were circled in the cells above. The descriptions provided in Section 1 of this document may be helpful. There is no formula or mathematical calculation to arrive at this overall judgment for the area.

	Social Inventory WALROS Classification (circle number)										
	Urban		**Suburban**		**Rural Developed**		**Rural Natural**		**Semi-Primitive**		**Primitive**
LAKE ZONE 1	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 2	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 3	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 4	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 5	1	2	3 4		5 6		7 8		9	10	11

Question 3. Management Inventory Protocol

Please complete each attribute section for each of the five lake study zones. Rows are provided under each inventory question with lake study zones. Please circle the lake study zone which applies to each category selected.

Management Inventory Protocol Sheet						
Degree of management structures – Degree that management facilities, buildings, interpretive signage, equipment, buoys, mileage markers, entry stations, towers, security lighting, and administrative offices and compounds are present.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Distance to onsite developed recreation facilities and services – Mileage to developed campgrounds, restaurants, stores, medical services, marinas, resorts, pump stations, amphitheaters, picnic sites, play areas, telephone, showers, visitor centers, etc.	Less than 0.5 miles	0.5-2 miles	2-5 miles	5-8 miles	8-10 miles	More than 10 miles
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Distance from developed public access facilities – Mileage to developed and well-maintained access points such as parking lots, trailheads, entrances, boat launches, access roads, and other staging and launching areas.	Less than 0.5 miles	0.5-2 miles	2-5 miles	5-8 miles	8-10 miles	More than 10 miles
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Management Inventory Protocol Sheet						
Frequency of seeing management personnel – Likelihood of seeing management presence such as rangers, local sheriff, or police, entrance station staff, hosts, maintenance workers, lifeguards, marina operators, concessionaires, guides, and other people of authority.	Extensive, dominant, or a great deal 80-100%	Very prevalent or widespread 50-80%	Prevalent, common, or apparent 20-50%	Occasional, infrequent, or periodic 10-20%	Minor, little, or seldom 3-10%	Very minor, very little, or rare 0-3%
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

After each attribute is checked or circled on the scale of degree, circle the number in the table below for each lake zone that best represents your overall judgement of the area. The odd numbers represent the six WALROS classes, while the even numbers represent the midpoint between two WALROS classes. This decision should be based on your sound professional judgment, preponderance of the evidence, and how the attributes were circled in the cells above. The descriptions provided in Section 1 of this document may be helpful. There is no formula or mathematical calculation to arrive at this overall judgment for the area.

	Management Inventory WALROS Classification (circle number)										
	Urban		**Suburban**		**Rural Developed**		**Rural Natural**		**Semi-Primitive**		**Primitive**
LAKE ZONE 1	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 2	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 3	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 4	1	2	3 4		5 6		7 8		9	10	11
LAKE ZONE 5	1	2	3 4		5 6		7 8		9	10	11

The WALROS boating capacity range decision tool helps ensure that important factors are considered by managers when deciding what part of the range may be most appropriate for the area in question. Also, it helps to document the reasoned analysis used in making a boating capacity decision. The range decision tool can be seen in **Question 4.**

Question 4. WALROS Range Decision Tool

For each WALROS zone, consider the following factors that may affect boating capacity. Circle the lake zone(s) that best matches the situation. Based on these responses, circle the overall suggested capacity range for each lake zone at the bottom of this table. The preponderance of the answers will indicate which part of the capacity range may be more reasonable.

Typical size of boats	**<15 feet**	**16 to 25 feet**	**>25 feet**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Typical speed of boats	**<10 mph**	**10 to 25 mph**	**>25 mph**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Diversity of boating			
1. Different types of boats	**Low**	**Moderate**	**High**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. Different size of boats	**Low**	**Moderate**	**High**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. Different speed of boats	**Low**	**Moderate**	**High**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Boater visitation pattern	**Simple/Predictable**	**Moderate**	**Complex/Unpredictable**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Level of boater stewardship/civility/ respect for resource and other visitors	**High**	**Moderate**	**Low**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Shoreline configuration	**Simple/Circular**	**Moderate**	**Complex/Meandering**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Boater destination or pass-through area	**Pass-Through Corridor/ In-Transit**	**Mixed**	**Destination Area / Overnight Area**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Extent of sensitive resources/potential for impact	**Low**	**Medium**	**High**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Compatibility with adjacent recreation/non-recreation land uses	**High**	**Moderate**	**Low**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Islands/shallows/hazards	**Infrequent**	**Occasional**	**Frequent**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Historic public safety record / accidents / complaints / conflicts	**Infrequent**	**Occasional**	**Frequent**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Level of boater management / rules / information / education / compliance	**High**	**Moderate**	**Low**
Lake Zone (circle)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Suggested Capacity Range	**Lower End (more boats)**	**Mid-range**	**Higher End (fewer boats)**
Lake Zone (circle)	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**

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