W9127S-07-D-0017 Task Order 02

Recreational Boating Use Study
Table Rock Lake, Missouri

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PREPARED FOR
U.S. ARMY CORPS OF ENGINEERS
LITTLE ROCK DISTRICT

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U.S. Army Corps of Engineers
Little Rock District

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EXECUTIVE SUMMARY

Table Rock Lake is a US Army Corps of Engineers (USACE) managed lake located in southwest Missouri primarily in Stone and Taney Counties. The lake has a full conservation pool covering 43,100 acres and 745 miles of shoreline. The lake contains more than 106 resort leases, 203 recreational areas, 107 picnic sites, 1,242 camping sites, 14 marina concessions, 1,800 boat docks, and 140 boat ramps. There are approximately five million visitors to the lake each year. These visitors are involved in recreational activities including picnicking, camping, swimming, water skiing, boating, sightseeing, fishing and hunting.

The USACE is charged with the complex management task of providing safe and enjoyable recreation opportunities while also protecting the natural resources where those recreational activities occur. At the same time, they must address very specific and important water resource issues such as user conflicts, dispersion of lake access points, and new commercial boating recreation developments (marinas, rental operations, and existing boating recreational facility expansions). In order to better understand and facilitate these opportunities the USACE contracted with Cherokee CRC, LLC to conduct a recreational boating use study on Table Rock Lake.

The purpose of the study was to assess boaters' perceptions and preferences for various managerial, social, and physical resource conditions on the lake. More specifically, the study focus was to determine boater capacity, density, crowding, and public safety on the lake. In addition, it involved identifying the boaters' most important issues. The boater survey was conducted between May 25th and August 16th, 2009. There were five primary objectives:

- describe the recreational patterns of two boater groups (public launch ramp users and those who are marina slip renters, slip owners or shoreline residents);
- determine the boaters' perceptions of present and past natural, social, and managerial conditions including perceptions of crowding, congestion, and conflict;
- determine the boaters' preferences for natural, social, and managerial conditions;
- quantify the amount and character of recreational boating use occurring during the primary boating season, and;
- test and refine the inventory procedures developed at other lakes.

The survey methodology included the use of exit interviews, questionnaires and mail-back inventory instruments. To obtain a representative sample population and data set, it was determined to interview launch ramp users, and obtain mail-back surveys from marina "slip" renters, private slip owners and shoreline residents. The goal was to interview approximately 400 ramp users, and obtain approximately 400 individual mail-back surveys from each of the marina "slip" users, private slip owners and shoreline residents. The boater survey obtained a total of 358 launch ramp user interviews and 676 mail-back surveys returned via mail. The total sample population size was 1,034 boaters.

The sample population data set was analyzed using inferential statistics. Inferential statistics are tools used to draw larger generalizations from observing a smaller portion of data (boater survey results). The statistical analysis included the use of stratified random techniques (lake zones & launch ramp selections), random techniques (exit interviews, mail-back surveys), Likert-scaled items (survey questionnaire), Dillman's sampling strategy and validity checks using the Statistical Procedures for the Social Sciences (SPSS™). In addition, the sample population data set was graphically represented using displayed using ArcMap™ software

Though a nearly inexhaustible series of statistical analyses can be done on the data set, a decision was made to present this information in the form of grouped responses and percentages. The intent is to "paint a picture" and provide a baseline of the boater populations on the lake and facilitate an understanding of their make-up and activity.

The first part of the survey describes boaters in terms of length of experience, frequency of lake use, distance traveled to the lake, duration of visit, boat type and size, and boating activities. The majority of the marina slip renters, slip owners and adjacent land owners (mail-back survey respondents) have visited the lake before 2009 and the majority held more than 16 years of boating experience. Boaters with the longest histories will be the most accustomed to the lower-density recreation opportunities that the lake used to provide (historically) and are, generally, more sensitive to social impacts. It follows that these veteran boaters are more likely to oppose new developments, especially in areas that are presently undisturbed. Most of the boaters interviewed lived in Missouri and traveled less than 30 miles to the lake. Both groups visited most frequently on weekends; the largest portion of ramp users (31%) and mail-back survey respondents (41%) visited the lake more than 50 weekend days in the previous year which indicates high local and loyal use. It follows that boater conflicts will be most likely to occur during times of peak usage. The majority, 47% of ramp users and 51% of mail-back survey respondents, stayed four to six hours during each visit. Runabout boats were the most popular watercraft among ramp users (39%) and mail-back survey respondents (40%). Mail-back survey respondents used larger boats with more horsepower; 23 feet and 217 horsepower on average; ramp user's boats averaged 19 feet and 171 horsepower. There are only small differences in the way ramp users and mail-back survey respondents spent their time on the lake; cruising, fishing, and skiing were the most popular activities with each group.

The locations boaters favored on the lake varied, but the conditions they sought were similar. The largest portion of each group indicated that convenience followed by solitude were the attributes of their favorite places. This finding is consistent with results from other boater capacity studies. As with favored locations, the places boaters avoided were varied, but the conditions they avoided were not. The largest portion of each boater group cited overcrowding, traffic, and rough water/ hazards as attributes of locations they avoided. Similarly, crowding followed by water conditions or obstructions were features that made boaters feel unsafe. Mail-back survey respondents were more sensitive to boat traffic and unsafe boating behavior than were ramp users. Although boaters reported avoiding some areas of the lake due to safety concerns, the majority of each group (84% of ramp users and 76% of mail-back survey respondents) reported feeling "extremely safe" on the lake.

Seventy-nine percent of ramp users and 41% of mail-back survey respondents felt that the lake was "not crowded." Many respondents indicated that increases in ranger patrols, new regulations, and facilities improvements enhanced their experience in a positive way. In contrast, increased boater traffic, personal watercraft usage, undesirable policy changes, facility decline, fluctuating water levels or poor water quality negatively diminished their experience. Many visitors desired restrictions on personal watercrafts and rule enforcement. Mail-back survey respondents desired additional campgrounds or parking facilities. Although there were some requests for additional facilities, more than 68% of each boater group felt that the current number of parking areas, boat ramps, and marinas was "about right."

Much has been learned during this study in regards to how much and how often boaters use the lake. The data set provides key findings that can be used for management purposes. The key findings include;

- Managing the Class I or Class II management compartment classifications which have a higher conflict/density.

- When viewing the management compartment classification maps for the 20% to 100% projected increases in average number of boats, it appears that at a 60% increase in boats above the number of boats counted in this study, there is a threshold of crossing nearly half of Table Rock Lake's management compartments as being a Class I designation for density/conflict. Therefore, management should strive to conserve use levels to prevent these levels from exceeding this threshold. Without this type of management strategy, opportunities for other classes of experience on the lake will be eliminated and those boaters looking to fish, swim, or relax quietly will likely be displaced elsewhere to seek out their recreational experiences.

- Problematic areas identified as areas to avoid and that are unsafe by boaters in these Class I compartments include Kimberling City, the dam area, the main channel, the state park, and Aunt's Creek among others. To mitigate the negative attributes cited by boaters for why they avoid those locations, management will need to consider increasing law enforcement strategies to curb unsafe boating behavior, illegal behaviors associated with alcohol consumption, enforce or post speed limits, and remove debris hazards from the water.

- Visitors also cited crowding and boat traffic as primary reasons for avoiding the unsafe locations mentioned above. Social condition strategies to reduce crowding/density may include reducing parking, slips, leases, or concessions or other development near the above locations on the lake. Other strategies to mitigate the above social impacts that could be considered include dispersion strategies or temporary closures of areas to rehabilitate the resource and redirect traffic to other locations.

- Some locations were much more important to boaters such as Cape Fair, Cow Creek, Aunt's Creek, and Long Creek. Ramp users and mail-back survey respondents, as a majority, cited close, familiar, solitude, relaxing, good fishing, good facilities, and calm water/scenery, as the primary reasons that they visited their favorite location. To manage for these qualities, it appears that these favorite locations should contain low speed or no wake zones to allow for calmer water, better fishing, and quieter solitude for relaxing.

- The results of inferential statistics in this study indicate that perceptions of crowding are correlated with the need for more facilities such as boat ramps, parking, and marinas. This finding indicates that the development of more adequate facilities could decrease perceptions of crowding among TRL boaters. This may be particularly true for those boating on cabin cruisers who preferred additional marinas. Fishermen appear to be significantly opposed to additional developments such as building more boat ramps. Crowding perceptions correlated with perceptions of safety indicating that increasing use could increase perceptions of danger among boaters conducting their recreational activities on TRL.

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1.0 Introduction

Table Rock Lake is a US Army Corps of Engineers (USACE) managed lake located in southwest Missouri primarily in Stone and Taney Counties. The lake has a full conservation pool covering 43,100 acres and 745 miles of shoreline. The lake contains 106 resort leases, 203 recreational areas, 107 picnic sites, 1,242 camping sites, 14 marina concessions, 1,800 boat docks, and 140 boat ramps. There are approximately five million visitors to the lake each year. These visitors are involved in recreational activities including picnicking, camping, swimming, water skiing, boating, sightseeing, fishing and hunting.

The USACE is charged with the complex management task of providing safe and enjoyable recreation opportunities while also protecting the natural resources where those recreational activities occur. At the same time, they must address very specific and important water resource issues such as user conflicts, dispersion of lake access points, and new commercial boating recreation developments (marinas, rental operations, and existing boating recreational facility expansions). In order to better understand and facilitate these opportunities, the USACE contracted with Cherokee CRC, LLC to conduct a recreational boating use study on Table Rock Lake.

1.1 The Problem

The rapid increase of use experienced at many lakes in recent years, including Table Rock Lake, has a significant effect on the quality of water-based recreation. Increased use has the potential to make high-density, less "nature-oriented" experiences dominant and to reduce or eliminate the opportunity for experiences centered on the enjoyment of solitude, peace and quiet, and natural scenery. This increase in use can also depreciate the quality and the availability of certain activities such as water skiing and fishing, which require space and fewer wakes to participate in them. The public launch ramps at Table Rock Lake have seen more visitations and are often congested during high-use periods such as weekends and holidays. Due to the recognized congestion, concerns about development and expansion are now being considered at Table Rock Lake.

With increasing visitation, Table Rock Lake managers are under duress to address these kinds of problems. While management has received requests for additional development and boat ramps, they also suspect escalating social problems on the lake, including increasing conflicts between traditional boaters, larger craft types, fishermen, and jet skiers. Balancing these requests, while continuing to provide safe and enjoyable recreation opportunities for boaters, requires providing a full range of experiences. These vary from the low-density, "get-away" type to the higher-density, more social experiences.

1.2 Objectives

The primary objective for the Table Rock Lake study was to:

> Assist USACE managers and stakeholders with understanding increasing boating use, congestion/conflict, and shoreline development pressure at Table Rock Lake, Missouri.

The secondary objectives were to:

1. Describe the recreational patterns of two boater groups: public launch ramp users and users who are marina slip renters, slip owners and land owners;

2. Determine boaters' perceptions of present and past natural, social, and managerial conditions including perceptions of crowding, congestion, and conflict;

3. Determine boaters' preferences for natural, social, and managerial conditions;

4. Quantify the amount and character of recreational boating use occurring during the primary boating season;

5. Test and refine inventory procedures developed at other USACE lakes;

Photo Courtesy of OzarkLand.com (**http://www.OzarkLand.com**)

1.3 Review of Literature

1.3.1 Recreational Boating Capacity

Recreational boating capacity is a concept borrowed from other resource management specializations, such as range management and wildlife management. The concept implies that specific land areas have certain use or production capacities that are sustainable, and that these capacities can be identified and managed. In the current study, it was expected that Table Rock Lake would have management compartments with higher use density and conflict than other compartments and that these areas would have higher levels of incidents/accidents.

Ideally, the determination of boating capacity would be accomplished by applying a simple formula for calculating a manageable limit or specific number of watercraft for an entire body of water. However, given the sheer diversity of boats on the water today and the variability of their uses, such calculations can only provide a crude estimate of capacity. Therefore, the concept of recreational boating capacity on rivers, lakes, and reservoirs is complex. To obtain an accurate picture, estimation of boating capacity must include information about current boating conditions and identify a desired future condition that is agreed upon by managers, visitors, partners and stakeholders. Once this is accomplished, appropriate strategies can be developed to address objectives for short and long-term planning.

In 1982, Washburne proposed that recreational carrying capacity be conceptualized as a set of conditions (physical-biological, social, and managerial) to be managed, rather than an upper limit of visitor numbers. During the past few years, various processes - Limits of Acceptable Change (LAC), Visitor Impact Management (VIM), Carrying Capacity Assessment Process (C-CAP), and Quality Upgrading and Learning (QUAL) - have been developed to gather and integrate various kinds of information for an area, and to indicate desired conditions. This study applied aspects of the QUAL process (Chilman 1989) with emphasis on inventory of current conditions and discussion of results. In this process, future desired conditions are identified in a data-gathering phase, which is based on public input. Other procedures attempt to set management objectives prior to the consideration of how people use the resource.

Visitor capacity studies evaluate the impact proposed changes will have on users. Reporting and analysis procedures have been successfully developed at several smaller lakes (less than 3,000 acres) managed by the USACE. More recently the methodologies have been tested at Granbury, Possum Kingdom, Beaver, and Norfolk Lakes (Titre and Vogel 1993, 1995, 1996; Titre and Jones, 1995). Boating capacity data resulting from these studies have been used to evaluate proposals for additional shoreline development. This includes boat launch ramps, marinas, or private docks that, in addition to aesthetic impacts, have the added result of potentially increasing boat traffic density, crowding, noise, and conflicts.

1.3.2 Boating Conflict

Conflict is defined as a negative experience occurring when competition for shared resources prevents expected benefits of participation from accruing to an individual or group. Crowding, noise, displacement (being forced to find other locations), goal interference, and negative perceptions of safety are all potential causes of boating conflict. The majority of recent boating studies have primarily focused on crowding and goal interference as causes of conflict in water resource settings.

People are generally goal-oriented when engaging in a recreational activity, such as boating. Expected goals are anticipated when participating in recreational boating (Driver & Tocher, 1970). Conflict in recreational boating occurs when an individual or group is faced with interference in obtaining a desired goal, which then creates dissatisfaction with the actual experience (Jacob & Schreyer, 1980). The four main factors related to boating conflict are activity style, resource specificity, mode of experience, and lifestyle tolerance (Jacob and Schreyer, 1980). Activity style is the assigned personal meaning that an individual connects to an activity (Jacob & Schreyer, 1980). Resource specificity is participating in a recreational activity using a certain recreation resource that has a significant personal value attached to it. Mode of experience is how the natural environment is perceived in comparison to the expectation. Lifestyle tolerance is accepting or rejecting lifestyles that are different than one's self. Combinations of these four factors are how most conflicts occur (McAvoy, Gramann, Burdge & Absher, 1986).

A study by McAvoy and colleagues (1986) examined the types of conflicts that can occur between recreational and commercial users of the Upper Mississippi River System. This research was used to determine how management could improve water safety. The findings showed that differences in activity intensity, boating experience level, and possessive attitudes of boat users can cause conflict. Another example of conflict is demonstrated in a study by Manning (1999), in which it was found that paddling canoeists were relatively tolerant of other canoeists, but were more resentful of encounters with motorized canoeists and greatly disliked motorboats. Therefore, a limited amount of shared resources tends to create competition between individuals or groups and reduces the quality of the experience (Owen, 1985). This assumption means that crowding can cause conflict with recreation participants.

One study conducted by Wang and Dawson (2005) examined the goal interference model of boating conflict among three different user groups in New York State's Great Lake coastal areas. Motorboat users, personal watercraft users, and riparian landowners were asked about levels of perceived conflict and the source of that conflict. Each respondent was also asked a series of questions intended to measure the dimensions of the goal interference model: activity style, resource specification, mode of experience and lifestyle tolerance. A linear function was constructed that modeled goal interference as a function of all the elements of these dimensions. Logistic regression models indicated that one or more dimensions were significant in predicting perceived conflict and the models correctly predicted conflict in over 70% to 100% of the cases. While there was some variation, activity style was the most frequent significant predictor of goal interference. Generally, however, goal interference theory can be seen as a general model, and the significance of each of the four dimensions depends on the types of recreation activities and users.

Other studies of goal interference have examined conflicts among water skiers and fishermen as well as personal watercrafts (jet skis). Gramann and Burdge (1981) reported the incompatibility of social, psychological, or physical goals between boater groups. They found only weak support for their incompatibility of goals hypothesis. Variations in conflict perception among fishermen were somewhat related to variations in recreation goals. For example, fishermen who placed greater emphasis on tension release, various forms of escape, and nature enjoyment were more likely to define high-speed boating as "reckless". The authors speculate

that much conflict is not related to goal incompatibility, but instead to competition for space. Later research on goal interference has emphasized that goal interference may occur even when recreation users share similar goals, such as participating in their respective activities (and interacting in space) may be enough to cause significant goal interference.

Roe and Benson (2001) examined conflicts associated with personal watercrafts (PWCs) for the Northumberland coastline. Rather than research focusing on conflict situations at a specific recreation site, their research used a survey of 150 recreation interest groups and agencies to highlight specific issues with PWCs and comment on appropriate management actions. Management suggestions included legislation, voluntary agreements, zoning, control by clubs, physical barriers, and information and publicity. The results of the survey were used to develop a strategic framework that would act as a mechanism under which conflicts could be identified and resolved. The principles adopted and the study approach and methods illustrate a useful way to provide locally relevant proposals to deal with the dilemmas of managing "new wave" sports, such as jet-skiing in ecologically sensitive and aesthetically important coastal landscapes.

1.3.3 Crowding and Density

The degree to which one perceives that the number of other boaters makes them feel crowded at a recreational area is the literal definition of crowding as it relates to recreational boating. Crowding is also defined as being the negative evaluation of a density of people in a certain amount of space (Russell, 2005). Additionally, crowding is the negative perception of spatial limitation relative to the boater, and density is the actual physical limitation of space provided by the water resource (Stokols, 1972).

Perceptions of crowding can come from the personal characteristics of boaters, the characteristics of other boaters that are met, and the attributes of the water resource setting (Russell, 2005). These can be broken down into other factors that include motivations for participation, behavior of other boaters, and location of contacts (Kuss, Graefe & Vaske, 1990). The personal characteristics of a boater could be that they are motivated to participate in a recreation activity to be alone or with a group (i.e. sea kayaking or celebrating on a houseboat; Kuss et al. 1990). Based upon their motivation, they may or may not feel crowded when they are surrounded by a large amount of other boaters. Secondly, meeting other visitors that are unlike one’s self can depend upon the tolerance of an individual (Russell, 2005). This can be demonstrated with an example of recreational boater participants. A recent study showed that kayakers and canoeists would rather encounter visitors participating in either of these activities, instead of rafters (Tarrant, Cordell & Kibler, 1997). Therefore, the behavior of the participants and tolerance towards them impacted the feeling of crowding more than the actual number of people. Lastly, the nature of the setting can make a space feel more crowded depending on where encounters take place. The feeling of crowding can differ depending on if the boaters are in a clean, wide, open area of the lake or if they are in a dirty enclosed space, such as an overused boat ramp surrounded with litter (Russell, 2005).

Tseng and colleges (2009) researched the relationship between crowding and satisfaction at three lakes that reside along the lower Colorado River basin. They examined the expectations of setting density, safety perceptions, and satisfaction to help managers dealing with issues of high population growth in recreational boating. The study found that respondents encountered more users than expected, which made them feel crowded and considered the lake to be unsafe.

In a study of boating density, based on previous standards and field observation, Jaakson et al. (1990) determined the following acreage specifications were appropriate for their study area: 20 acres per boat for motorboat cruising, 20 acres per boat for water skiing, 10 acres per boat for fishing from a boat, 8 acres per boat for canoeing and kayaking, and 8 acres per boat for sailing. Jaakson et al. emphasized that their conclusions were value judgments based on field observations. Such findings are not readily transferable to other lakes, but should be adjusted according to "the morphology of a lake, cultural tolerances of density, and safety considerations of the manner in which water-oriented recreation activities are carried out" (Bosley, 2005; Kusler, 1972).

1.3.4 Boating Safety and Accidents

Previous studies have demonstrated that perceptions of boating safety as well as accident statistics have been significantly correlated with crowding, satisfaction, enjoyment, and density among recreational boaters**.** Tseng et al. (2008) found that crowding and expectations of seeing others was negatively correlated with boating safety perceptions. Crowding and expectation of seeing others was shown to account for 10.3% of the variance in boating safety perceptions. Tseng and others also report that recreational satisfaction was positively correlated with boating safety and enjoyment. They conclude that safety and enjoyment explained 11.2% of the variance in boating satisfaction.

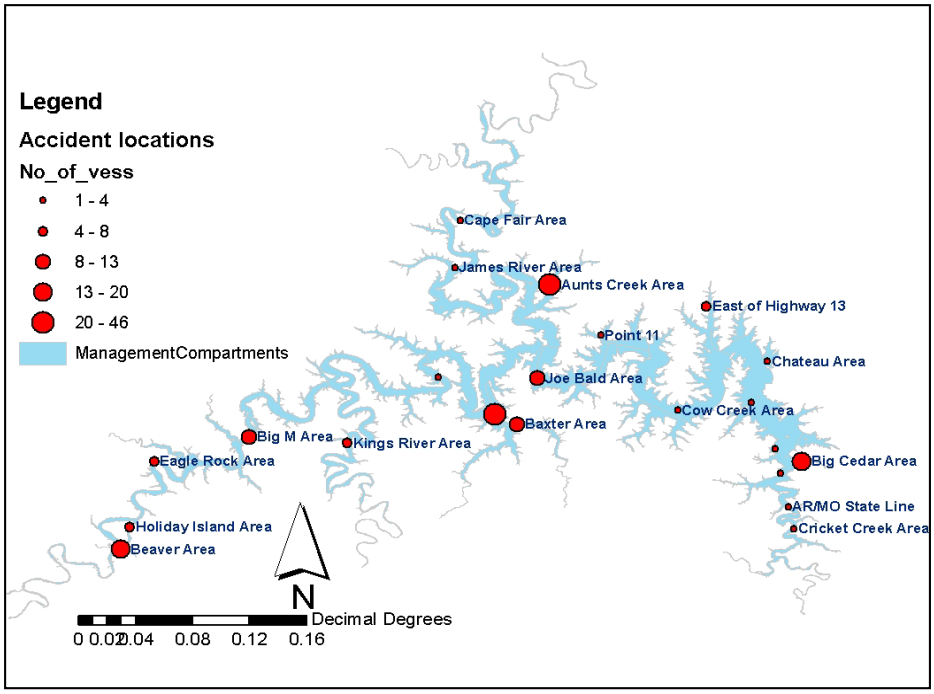
Recognizing the role of density in predicting safety hazards for boaters, Kopke et al. (2006) formulated a calculation for the optimum number of boats in Cork Harbour, UK. They present a formula for calculating the safe number of boats on the Harbour. This formula involved the study area being divided by boating density in kilometers and produced an estimated 1611 boats were optimum for boating safety standards.

Recreational boating accident statistics have been well recorded at the national and state levels. Duda et al. (2002) state that nearly one third of recreational boaters reported being involved in an accident or near accident (American Red Cross, 1991). About 11% of these boaters reported being involved in a "high risk incident" in which they felt their lives were threatened, 9% reported being in an "urgent situation' requiring help from others, and roughly 6% reported being in some sort of minor accident. In addition, 5% of these boaters reported involvement in an accident leading to death, injury, or property damage. This seems to support the contention that actual accident rates in recreational boating are higher than official records indicate. A boater's perception of safety effects the decision to wear a Personal Flotation Device (PFD). Boaters in the Mangione (2000) study reported under what conditions they are most likely to wear a PFD. Boaters are more likely to wear PFDs in situations perceived as "risky", such as water skiing (94%), rough water (66%), strong currents (61%), and strong winds (61%). They are less likely to wear a PFD in situations perceived as less risky. Only 16% see any danger while at anchor and only 25% see fishing activity as being dangerous.

In Virginia, safety and access issues topped the list of items that boaters wanted the Virginia Department of Fish and Game to better address. Safety issues included controlling boaters under the influence of alcohol or drugs, controlling reckless operation, and boating safety education (McMullin et al. 2000; Responsive Management 2000b). Virginia boaters were most concerned about reckless/careless operators and the use of alcohol and drugs (35%).

Nationally, The US Coast Guard recorded 4,789 recreational boating accidents from around the nation in 2008, resulting in 709 deaths and 3,331 injuries (Office of Auxiliary and Boating Safety, 2009). The leading cause of accidents was reckless operation, operator inattention, no proper lookout, operator inexperience, and passenger behavior. Personal water crafts (PWCs) represent only a slight portion of all registered boats (11%), however they are involved in 35% of accidents and 44% of injuries (Burger & Leonard, 2000). Drowning accounted for more than two-thirds of the cause of deaths in boating accidents, with 90% of the fatal victims not wearing lifejackets (Office of Auxiliary and Boating Safety, 2009). Drowning is also a major concern for the U.S. Corps of Engineer lakes. In 2001, the Southwestern Division of the USACE lakes recorded 45 deaths by drowning, with none of the victims wearing life jackets (U.S. Corps of Engineers: Media Kit). Table Rock Lake is one of the lakes located within the Southwestern Division of lakes (**Figure 1**). The U.S. Department of Transportation (U.S. Coast Guard Boating Statistics, 2004) states that recreational boating accidents in Missouri can be summed up as follows: alcohol related boating accidents ranked the highest in the nation, totaling 65 occurrences (1st of 51 states recorded); deaths in alcohol related events ranked 5th out of 51 states studied, with a total of 10; boating related fatalities totaled 17 (14th) and injuries totaled 170 (4th); and injuries related to alcohol totaled 64 (1st) and accidents totaled 201 (5th). These statistics indicate a strong need for increased law enforcement and boating safety education on Missouri lakes.

Figure 1. Accident/Incident Locations on Table Rock Lake



1.3.5 Impact of Water Quality on Recreational Use

Table Rock Lake has had decreasing water clarity and was listed as having impaired water as a result of nutrient enrichment in 2002. The increase in nutrients and chlorophyll has led to a decrease in the clarity of the water that has been noticeable since the early 1990s. The main causes of excess contaminants in the water are from wastewater treatment, urban storm water, and agricultural runoff.

The water at Table Rock Lake is used for livestock and wildlife watering, swimming, boating, and other recreational activities. The clarity of the water is decreasing because of the increasing amounts of nitrogen and phosphorus, plant nutrients that increase algae. The increase in residents and tourists, commercial and industrial development, and livestock growth have also contributed to the decreasing water quality. The Upper White River Basin Foundation, the Table Rock Lake Water Quality, Inc. and the James River Basin Partnership are all working to reduce nutrient runoff and improve the water quality at Table Rock Lake (Missouri Department of Natural Resources, 2005).

Freeman (1995) analyzed the impact that water quality has on recreational activities. The results showed that water quality was important to recreational and commercial users, but depended on the type of activity that was participated in. For example, fishermen did not value water quality so long as they had a high catch rate and there was an abundance of fish available. Boaters that use a trailer to put their boat in the water were more likely to value high water quality.

Health problems can occur from swimming in poor quality water. These problems are usually gastrointestinal and can be caused by wastewater pollutants. The negative effects that water has on users' health should be used to determine the level water quality that is acceptable for recreational participation. Guidelines and regulations for acceptable water quality to reduce risk of illness differ between organizations, such as the Federal Water Pollution Control Administration and the U.S. Environmental Protection Agency. However, it is agreed by many organizations that the fecal coli forms should be used to measure and evaluate the suitability of recreational water (Cabelli, et al., 1983). Recreational boaters are becoming more aware of information such as fecal counts and these statistics may, in turn, influence participation and satisfaction in boating, swimming, and water skiing on Table Rock Lake.

1.4 Need to Address Management Concerns

USACE managers are charged with the complex task of providing safe and enjoyable recreation opportunities, while protecting the natural resources where those recreational activities occur. At the same time, they must address other important water resource issues such as user conflicts, dispersion of lake access points, new commercial boating recreation developments, and expansion of existing boating recreational facilities.

Considerable information is provided about the conditions on Table Rock Lake; management tools to address those problems can be determined through discussion of the data with the public. Decisions about the best tools to use in specific places and development of

defensible responses to problems should take into account the study data, public input on management options, and the authority to regulate various aspects of boater activity and access.

1.5 Value Judgments and Management Information

Management actions inherently involve *value judgments.* Study data can provide insight into decisions regarding the amount of undisturbed shoreline and other aspects of scenic quality that should be maintained, the types of experiences to be offered, and the management practices to be applied. A leading researcher in outdoor recreation stated the role value judgments play:

> *"It is evident that outdoor recreation managers must ultimately make value judgments about the types of opportunities to be provided...but value judgments should not be arbitrary or implied. They should be an explicit and visible part of a well-documented planning process. In this way, management judgments might be developed in a more orderly and rational way, subject to public and professional participation and review (Manning 1999)."*

In order to provide for diversity and make tenable decisions about development requests, managers need to know boaters use Table Rock Lake and what their preferences are regarding the natural, social, and managerial environment on the lake. Information about use patterns and users' preferences allow managers to better understand the need for specific procedures and criteria with which to evaluate development requests and address problems.

1.6 Expanding Public Input and Focusing on Boaters

The current recreational management paradigm for boating capacity strongly equates *quality with diversity* (Manning 1999). Recreational managers strive to provide a diversity of quality recreation experiences to satisfy public needs. Meeting this goal requires learning about boaters' use characteristics and preferences, and the conditions they perceive to be detrimental to their experience. With this information, managers can plan actions that will preserve their ability to provide diverse recreational experiences, while alleviating user conflicts and other undesirable conditions.

Visitors may evaluate how well their recreational experiences satisfied their motivational needs with surveys. In water-based recreation, boaters are typically surveyed at the end of their visit or are contacted at home with mailed survey questionnaires. Responses provide managers with a description of their recreational activity and an "evaluation" of their experience. The fundamental question behind these efforts is: "Did the opportunities provided facilitate or hinder the attainment of the desired experience?" (Schreyer 1987). To better understand desired experiences, the following boater survey questions about perceptions of and preferences for conditions include:

a. Favorite and avoided locations
b. Changes noticed
c. Changes desired

Responses to each of the survey questions may yield several pieces of information including:

a. Desired conditions sought by different boater groups
b. Boater participation in different activities
c. Condition changes that altered boaters' enjoyment of the resource

In keeping with these information needs, the primary purpose of the Study of Boater Recreation on Table Rock Lake was to obtain data from boaters on their use of the lake, their perceptions and preferences regarding the natural resource, other visitors, facilities, and management policies.

1.7 Boaters' Perceptions and Preferences

Understanding the recreation resource requires knowledge of what attracts recreationists and what attributes of the setting (conditions) are essential for a high-quality experience. Often, boaters can provide better information on resource and social conditions (and how they are changing) than management personnel can obtain from routine or systematic observation. Also, studies have shown that managers and visitors often have very different perceptions of recreation impacts and problems (Downing and Clark 1979), appropriate behaviors, and management alternatives (Hendee and Harris 1970). In order to provide for diversity and to make defensible decisions regarding development requests and other issues, managers need information about how boaters are using the lake and what their preferences are regarding the natural, social, and managerial environment on the lake. Once the information is available on use patterns and user preferences, managers need specific procedures and criteria with which to evaluate requests and to address problems. However, this process begins with guiding concepts developed by the investigators of this study:

a. Principles
b. Process
c. Partnerships
d. Collaboration
e. Criteria

1.7.1 Principles

Outdoor recreation opportunities must be accessible. This implies that the public has access to forested lands and waters for natural resource based recreation regardless of economic or social status, gender, age, physical or mental disability, race, color, ethnic background, religion, or other differences. Public agencies are obligated to provide the public with access provided that the other three principles are met.

Outdoor recreation opportunities must be safe. A safe experience is one in which visitors are properly prepared and educated about their outdoor recreation environment and the potential risks they might encounter. They are able to make well-informed decisions and judgments about

their personal safety and the safety of others. They have the necessary skill to participate in the activity without unreasonable risk to themselves or others. A safe recreational experience is one in which the risks and threats to visitors have been reduced to the lowest appropriate level through advance planning, facility design, quality construction and maintenance, effective implementation of appropriate controls, and responsive adaptive management.

Outdoor recreation opportunities must be sustainable. All of the recreational opportunities provided rely on a healthy natural resource base. Without water quality, forests, wildlife, fisheries, and other natural features of reservoirs, the public would have little interest in boating or other types of recreation on public lands. If managers fail to maintain or improve the health of the natural resource base, recreation opportunities will decline rapidly. It is the responsibility of management to ensure that the public understands the connection between the health of the natural resource base and the quality of their experience.

Accordingly, to be sustainable, outdoor recreation opportunities and programs must: 1) seek to avoid adverse impacts and not harm the integrity of the resource consistent with ecosystem and watershed management principles, 2) maintain the health and vigor of natural resources whenever possible, 3) provide an opportunity for the visitor to experience the natural world, and 4) include an interpretive/educational component that increases the visitor's awareness of human dependence on the natural world.

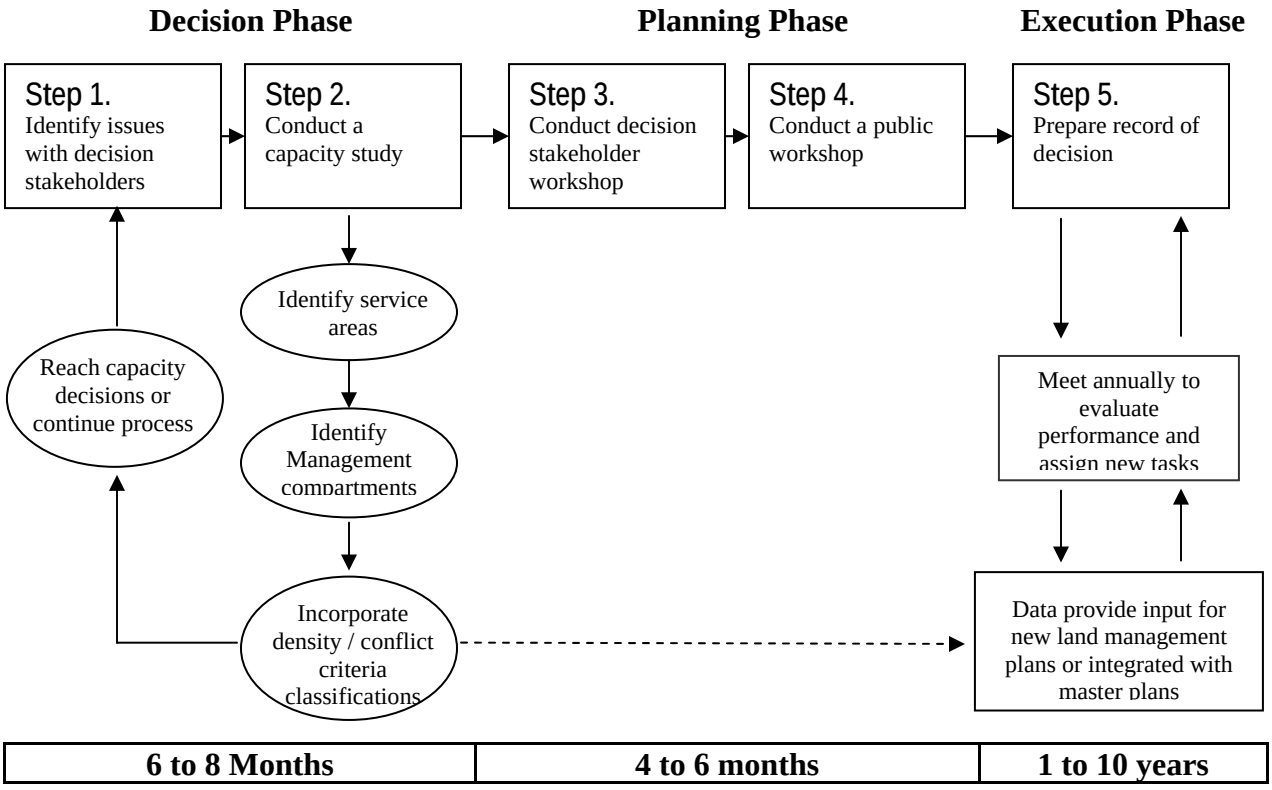
Outdoor recreation opportunities must be available to a diverse population. Being available to a diverse population implies more than being accessible to a cross-section of the American public; it includes a diverse population of recreation users. Diverse ethnic activity combinations from motorized to non-motorized and from boat to bank fishing are all legitimate uses of reservoirs. All water sport enthusiasts must be considered in the management of public resources. To be available to a diverse population, recreation opportunities must: 1) recognize the legitimacy of all users, 2) be equitable in our allocation of resources and facilities, 3) promote tolerance among user groups, 4) actively plan and manage to reduce conflicts, 5) provide opportunities for both solitude and social experiences, and 6) market for optimum appropriate use of available recreational opportunities.

1.7.2 Process

The five-step process in **Figure 2** is a collaborative learning model allowing for full participation of all stakeholders in decision-making at various stages. *Step 1:* A meeting is convened to elaborate the issues among decision stakeholders and to acknowledge the four principles. A neutral facilitator uses a modified Nominal Group Technique to generate issues. This first step actively engages all relevant decision-making stakeholders in a collaborative learning exercise establishing trust and familiarity with the group process and with individual participants. *Step 2:* Information is gathered at some level of detail depending on the complexity of the issues to be resolved (i.e., baseline studies can employ various data collection techniques such as rapid appraisal, 3-4 days, short-term baseline, 7-14 days, full-season baseline, 8-12 weeks). Once the data have been gathered and analyzed, the stakeholders reconvene a meeting (*Step 3*), group the findings into categories, and vote on proposed actions for each.

During the most recently completed studies, the following categories have surfaced on our nation's lakes: 1) crowding and recreation conflicts, 2) personal watercraft behavior, 3) the preservation of low-density and low-development areas and natural shorelines, and 4) facility maintenance and improvements.

Figure 2. Collaborative Learning Model for Capacity Decisions



1.7.3 Partnerships

Cherokee CRC, LLC recognizes two types of stakeholders. First, there are decision-making stakeholders who have some statutory responsibility for managing the resource. This group can also be called the "cooperating partners." Second, there are organized interest group stakeholders who care about some piece of the pie such as marinas, private slips, fishing tournaments, residential developments, and preservation of unique resources. The general public, both users and non-users, can be viewed as a third, albeit informal, stakeholder group. While it is important to include all stakeholders in the decision-making process, it is best to allow the three groups to participate at different times and within a different format.

It is common for reservoirs to be managed by several resource authorities. The shoreline, parks, fish and wildlife, and law enforcement responsibilities are typically managed by agencies with different missions. This fragmented authority makes it confusing for NGOs and "friends of the lake" to know where to turn for answers to management questions. Consequently, establishing partnerships is very important in the management of water resources. Further, it is

imperative for all decision-making stakeholders to be at the same table when issues are discussed (*Step 1*) prior to initiating a study (*Step 2*).

1.7.4 Collaboration

Once a list of proposed actions to address study findings is agreed upon, the collaborative learning process can go before interest groups and public stakeholders (*Step 4*). In contrast to bringing these groups together during initial stages of the process when only the issues and no data are presented, we recommend that non-decision-making stakeholders participate during the public workshop phase. While some may argue that this excludes the public from contributing to a "desired future conditions" vision, it has been our experience that individual and group concerns are accommodated through careful attention to the principles early in the process. More importantly, the test of fairness and equity as part of the evidentiary record depends on documenting all five concepts to demonstrate that a systematic and logical process has been followed.

In *Step 4*, three posters are prepared that describe: 1) what was done, 2) what was found, and 3) what is proposed. The workshop setting provides a non-confrontational atmosphere for discussing decisions before they are made. Decision-making stakeholders are present to answer questions and clarify information. Workshops are typically held during weekday evenings for about three hours and announced through the media. The principal investigator often prepares the posters and provides answers to factual and methodological questions. The same information is posted on agency Internet sites to allow additional stakeholders to participate in the process. *Step 5:* Once the public comments are analyzed, a final meeting is convened with decision-making stakeholders to prepare a record of decision. During this meeting, the proposed actions are reviewed in light of the study findings and the public comments from the workshop, Internet, and mail.

1.7.5 Criteria

During the past 20 years, resource management decision-making has gone through three distinct phases with respect to decision-making criteria. First, managers relied on professional judgment based on their training in forestry, wildlife, range, watershed, and recreation. This was later replaced by hiring an expert to prepare a report in support of a decision. Today, interested parties read agency reports and often dispute the criteria. Consequently, the third phase of support for decision-making requires that managers understand established criteria as sound technical evidence and that they are able to answer questions about study findings without further assistance.

The investigators of this study have applied these criteria with different agencies. With the Lower Colorado River Authority (LCRA), a court case was averted after the opposition council reviewed a report in 1995 related to expansion in Hurst Creek Cove.

The investigators of this study have also modified the Recreation Opportunity Spectrum (ROS, Driver and Brown 1978) to create one for water-based activities (WROS) on lakes and rivers. It can be viewed as a bottom-up/data-driven classification system (**Table 1**). Preliminary WROS criteria were developed for Lake Travis in Texas managed by LCRA (Titre, et. al., 1995, 1999; Vogel and Titre 1997). These criteria were successfully applied on Tims Ford Lake in

Tennessee in 2001 (managed by the Tennessee Valley Authority) and Carters Lake in Georgia in 2002 (managed by the U.S. Army Corps of Engineers). The criteria combine boating density and conflict data according to four classifications (**Table 2**). Managers determine the compartments prior to classification. Additionally, the four classes correspond well to the traditional ROS classes. Density data are gathered by recording boat types and their locations. Conflict data are gathered by showing boaters a map of the lake and asking them to identify avoided and unsafe locations. This results in a map that portrays existing boating conditions. Each density/conflict class is characterized by unique physical, social, managerial settings, and recreation experiences. These criteria provide documented evidence of boating conditions, as a basis for preparing management objectives, and place-specific information for addressing proposed developments.

Table 1. Water-based Recreation Opportunity Spectrum

WROS Class	Urban	Rural Developed	Rural Natural	Semi-primitive Motorized	Semi-primitive Non-Motorized	Primitive
Density / Conflict Class	**I** High Density, High Conflict		**II** Moderate Density, Moderate Conflict	**III** High Density, Low Conflict		**IV** Low Density, Low Conflict
Management Objectives	No New Development		Moderate Development	Partial Retention of Shoreline		Shoreline Preservation

Table 2. Management Compartment Classification Criteria Matrix

Boat Density (Acres/Boat)	**Use Level**	**Incidence Of Conflicts**		
		High	**Moderate**	**Low**
		(> 3.93%)	(1.21-3.93%)	(< 1.21%)
< 10.0	Very High	I	I	III
10.1 – 15.0	High	I	I	II / III
15.1 – 20.0	Moderate	I	II	II
20.1 – 25.0	Low	II	II	IV
> 25.0	Very Low	II	II	IV

1.8 Summary

While capacity decision-making will remain complex, adherence to these concepts will improve the likelihood that capacity decisions will be defensible and not arbitrary. To wait until the capacity situation is out of control on our waters is too late for taking advantage of these concepts. Indeed, Brown (2001) revealed that the most important recommendation from managers involved in capacity situations was that they act in a proactive manner. Finally, while citizen groups voice concern for protection of wilderness, parks, and wildlife refuges; lakes and reservoirs are often overlooked as places for solitude and the protection of resource integrity. These places provide excellent nature-based opportunities for escape from the pressures of modern living for a majority of the American public. The continued application and refinement of these concepts can contribute significantly to improved utilization of our nation's water resource heritage.

2.0 Methods

2.1 Introduction

USACE managers need an established procedure to use for gathering data on the amount and characteristics of boating use, as well as on the perceptions and preferences of boaters for the conditions they encounter during their boating.

The approach to information collection and analysis that was followed in this and preceding conflict classification studies at USACE lakes stresses detailed inventory of the resource and its use. Data collection for this study included boat counts on the water, exit interviews with boaters using public launch ramps, and mail surveys sent to marina slip renters, slip owners and adjacent land owners. The exit interviews and mail surveys focused on gathering information on use patterns, and on the perceptions and preferences of boaters using Table Rock Lake. The boat counts provide additional information about boat distribution.

Reconnaissance, inventory of the study area, and preliminary planning preceded the data collection. Study methodologies are provided below to explain the concepts and rationale behind implementation of this lake study.

Included in this study are boater exit surveys conducted at boat ramps from May 25th through August 16th, 2009. These lake users were asked questions about their perceptions of the conditions on the lake, what is important to them in their recreational settings, and changes that may be occurring. Boat counts were also used as a way to determine the location and type of boats on the lake.

2.2 Study Area

Table Rock Lake is a USACE managed lake located in southwest Missouri primarily in Stone and Taney Counties. The lake has a full conservation pool covering 43,100 acres and 745 miles of shoreline. The lake contains more than 106 resort leases, 203 recreational areas, 107 picnic sites, 1,242 camping sites, 14 marina concessions, 1,800 boat docks, and 140 boat ramps. There are approximately five million visitors to the lake each year. These visitors are involved in recreational activities including picnicking, camping, swimming, water skiing, boating, sightseeing, fishing and hunting.

2.3 Inventory of Boater Access Points

An inventory of all public launch ramps and marinas was completed prior to survey collection as the first step towards establishing a sampling plan. Public launch ramps were located and categorized based on information provided by USACE rangers and managers, as well as information contained in project records and maps.

2.4 Boater Survey

The boater survey portion of the study was conducted from May 25th to August 16th, 2009 (**Appendix A**). This survey was designed to gather information from all boaters using the lake including those who trailer their boat to public launch ramps, those who have a boat moored at a marina slip, those who own a private slip and those who reside along the shoreline.

Boaters using public launch ramps were interviewed after they had removed their boat from the water. Marina slip renters, adjacent land owners and slip owners were contacted through mail-back survey questionnaires (**Appendices B and C**). Exit interviews and mail surveys were conducted by research assistants, all of whom underwent interviewer training prior to the start of data collection. Sampling and data collection was coordinated by Cherokee CRC, LLC.

2.5 Sample Populations

The population for the study consisted of boaters using Table Rock Lake. For the purpose of sampling, the boaters were separated into two survey groups as determined by their mode of access to the lake: (1) public launch ramp users; and (2) slip renters, slip owners, adjacent landowners (hereinafter referred to as "mail-back survey respondents").

2.6 Sampling Methods

Two sets of observations were utilized for this survey: (1) a survey of lake users and (2) a physical, on the water boat count. The survey of lake users will gather perceptions while the physical boat count will provide supporting and congestion information.

Four sources of Table Rock Lake users were targeted for soliciting survey responses: (1) interviews with people removing their boats from the water at public boat ramps on Table Rock Lake; (2) a random mail survey of marina boat slip renters; (3) a random mail survey of Table Rock Lake slip owners; and (4) a random mail survey of adjacent land owners.

2.6.1 Sampling of Lake Users

2.6.1.1 Exit Interviews

A total of 91 public use boat ramps were identified on Table Rock Lake by USACE managers. The managers further refined those ramps into 13 "high-use" ramps, 20 "medium-use" ramps, and 58 "low-use" ramps.

A stratified random sampling was used to ensure representation of the entire range of boaters using the public ramps. The sampling strategy initially drew 40% of the on-site exit interviews from the high-use, 35% from medium-use and 25% from low-use areas. These periods were randomly placed into either the morning (8:00AM to 12:00PM), afternoon (12:00PM to 4:00PM) or evening (4:00PM to 8:00PM) periods. Progress was evaluated at the end of the first month of surveying and the number of completed surveys was below the estimated amount for that date. The sampling was redone with different ratios drawing 60% of the on-site exit interviews from the high-use, 30% from medium-use and 10% from low-use on the weekend days and 55% of the weekday interview from high-use, 25% from medium-use and 20% from low-use ramp areas.

Overall, there were 38 weekdays and 19 weekend days, plus the Memorial Day and Independence Day weekends scheduled for on-site boat ramp sampling over the investigative period. This methodological approach is consistent with previous studies (Titre et.al, 1995, 1996, 2005). A random number table was used to determine which boat ramps and days to schedule for the on-site exit interviews (**Appendix E**). The random number table was also used to determine the sampling period, whether morning, afternoon or evening. The surveys were conducted over a period from May 25th through August 16th, 2009.

The final result included in all 13 high-use boat ramps being selected between one and four times, 18 medium-use between one and four times and 14 low-use ramps being selected between one and two times (**Tables 3 & 4**).

Table 3. Allocation of Sampling Days for Boat Ramp Areas during Weekdays

High-Use Boat Ramp Areas	# of Sampling Days	Moderate-Use Boat Ramp Areas	# of Sampling Days	Low-Use Boat Ramp Areas	# of Sampling Days
Long Creek	1	Joe Bald	1	Bear Den Cove West	1
Viola	2	Castlerock	1	Turkey Mountain 2	1
Aunts Creek 1	2	Big M	1	Hoot Owl Point	1
State Park	2	Baxter	1	Emerald Beach	1
Aunts Creek 2	1	Bridgeport South	1	Anglers Bend	1
Mill Creek	3	Cow Creek	1	Bridgeport	1
Shell Knob Bridge	1	Kings River Park	1	Cow Creek – Nature Trail	1
Port of Kimberling	3	Outdoor Resorts of the Ozarks	1	Hobbs Hollow	1
Cape Fair 1	2	Big Bay (91)	2	Airport South	2
Moonshine Beach	2	Eagle Rock 1	1	Shawnee Woods	1
Cape Fair 2	2	Big Bay (89)	1		
Indian Point	2	Viney Creek	2		
Campbell Point	1	Cricket Creek 2	1		
		Eagle Rock 2	1		
		Abandoned 86	1		

Table 4. Allocation of Sampling Days for Boat Ramp Areas during Weekends					
High-Use Boat Ramp Areas	**# of Sampling Days**	**Moderate-Use Boat Ramp Areas**	**# of Sampling Days**	**Low-Use Boat Ramp Areas**	**# of Sampling Days**
Mill Creek	2	Big Bay (89)	1	Lakewood Terrace	1
Cape Fair 2	3	Eagle Rock 2	1	Stump Hollow	1
State Park	4	Old Hwy 86	1	Jackson Hollow	2
Aunts Creek 2	2	Holiday Island	2	Double Day Loop (Water Point)	1
Aunts Creek 1	1	Viney Creek	2	DD (Hidden Shores)	1
Campbell Point	1	Big M	1	Royal Point West	1
Port of Kimberling	3	Big Bay (91)	1		
Viola	2	Joe Bald	1		
Cape Fair 1	2	Cricket Creek 2	1		
Indian Point	2	Eagle Rock 1	1		
Long Creek	2	Castlerock	2		
Moonshine Beach	1	Big Bear	1		

2.6.1.2 Marina Slip Renters, Slip Owners and Adjacent Land Owners (Mail-back Survey Respondents)

Marina Slip Renters, Slip Owners and Adjacent Land Owners were the other three groups targeted in this survey. They were surveyed by a mail-and-return survey to their place of address (mail-back survey respondents).

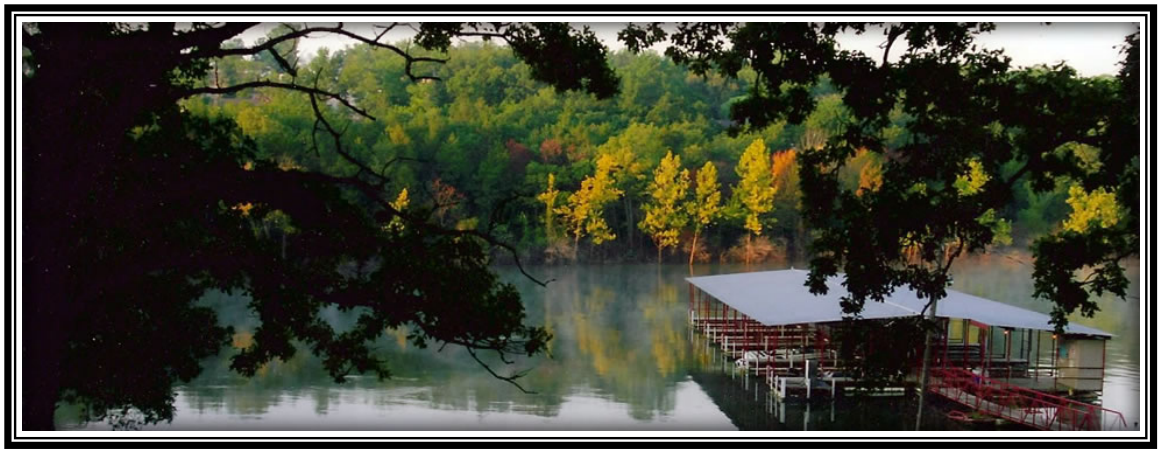
USACE managers contacted marina owners on the lake and acquired the list of their boat slip renters and relevant contact information. The surveys were randomly sent to 400 slip renters based off of this information. The distribution of slip renters was proportioned to the size of the marinas.

USACE managers maintain contact information on all slip owners and thus provided the necessary information. The surveys were randomly sent to 400 slip owners based off of this information.

USACE managers and Cherokee CRC, LLC assistants contacted the county clerk and assessor offices in both counties. The county clerk or assessor's offices were able to provide contact information of all adjacent land owners and thus provided the necessary information. The surveys were randomly sent to 400 adjacent land owners based off of this information.

Each mailed survey was sent using an approach pioneered by Dillman's sampling strategy. A cover letter, survey form and return envelope were sent together. One-third of the selectees were randomly assigned the "long-form" whereas the other two-thirds received the "short-form" survey (**Appendices B and C**).

Each form was assigned a unique, four-digit identification number to track when a survey was returned either complete or undeliverable. The initial mailing went out during the first week of August, 2009. Two weeks later, a post card was sent to all selectees to remind them to complete the survey. Three weeks after the post card, a new cover letter, survey and return envelope was sent to each of the selectees who did not return their original survey.



2.6.2 Boat Count

Boat counts were collected in each of the eight lake zones that were identified by key Table Rock Lake cooperation partners (**Figure 3**). The boat count sessions were all conducted between 1:00PM and 3:00PM on their scheduled days (**Table 5**). These times best approximate peak use periods. Each zone was counted once during a weekend session and once during a weekday session between May 25th and August 16th, 2009. The date and zone assignment was selected using a random number table. Zones 5 and 7 were selected by the USACE managers to be surveyed during the Memorial Day and Independence Day weekends. If adverse weather conditions were forecasted or occurring in the survey zone, the boat count was simply rescheduled on another weekend or weekday period, depending on the originally scheduled plan. As such, boat counts represent a "typical" day of either the weekend or weekday.

The boat counts were administered by a boat operator and an observer. The boat operator was responsible for operation, navigation and safety of the boat, while the observer recorded, on a map, the locations and type of watercraft.

Figure 3. Table Rock Lake Survey Zones

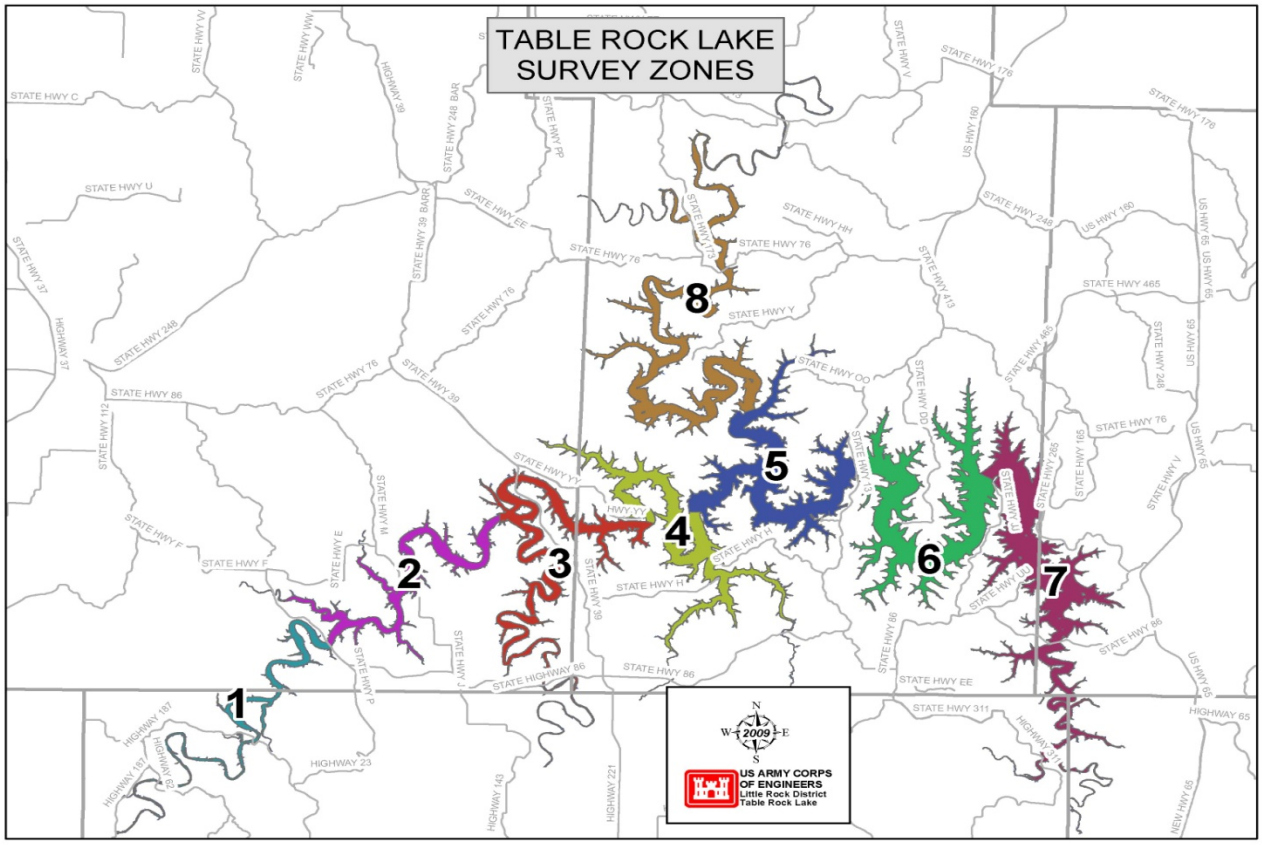


Table 5. The Schedule Boat Count Sessions for the Eight Zones on TRL			
Zone	**Weekday**	**Zone**	**Weekend Day**
One	8	One	55
Two	74	Two	191
Three	64	Three	159
Four	97	Four	146
Five	232	Five	368
Six	291	Six	461
Seven	1063	Seven	883
Eight	82	Eight	263

2.6.3 Survey Methods

The questionnaires for both the on-site and boat ramp exit interviews and the mail surveys sent to marina slip renters, slip owners and adjacent land owners generally contained the same set of questions. However, there was a "long-form" sent to one-third of the mail survey selectees (**Appendix C**). All of the questionnaires consisted of typical demographic items, experience use history, crowding, facilities and safety-related items.

A trained staff member approached every group who was removing their boat from the lake to conduct exit interviews. The staff member introduced himself/herself, explained the purpose of the study and solicited one volunteer to participate in a face-to-face interview. The interview was administered individually and not to the group. Once the interviewer arrived at the portion of the survey that had the Likert-scaled items, the questionnaire was handed to the respondent for self-administration. When finished, the respondent returned the questionnaire and graciously thanked the boater for his/her time and cooperation. Refusals were recorded if they occurred. Approximately 11% of parties approached refused to participate in the survey. Refusals were typically due to time, weather or intoxication. Most boaters appreciated the opportunity to talk about their experience.

Although every exiting boater group was desired, if more than one group were exiting at the same time that the survey assistant was available to interview, the survey assistant would first approach the group first obviously available.

2.7 Survey Instruments

One area of emphasis during the conflict classification studies conducted has been the development of explicit procedures to inventory existing conditions. An important aspect of this has been the development of a short set of questions to ask visitors. These questions establish an image of their perceptions of "quality" conditions in the area. This set of questions has been used at several areas supporting land-based and river-based recreation and were used during previous pilot tests at several other USACE lakes.

Information is obtained about visitor and visit characteristics, how the study area compares to other similar areas in the region, visitor's perceptions and preferences for use levels, perceptions of conflicts and changes. The questions have been kept short to be easy to administer and tabulate features of the survey.

2.8 Boater Questionnaire Survey

I. Visit Characteristics

- Length of experience
- Distance travel
- Frequency of visits
- Length of present visit (ramp users)
- Type(s) of watercraft used
- Activities participated in
- Portion of recreation day devoted to specific activities

II. Spatial Use Characteristics

- Location where activities were participated in
- Characteristics and location of favorite places
- Characteristics and location of avoided areas

III. Comparison to Other Areas

- Alternative boating locations
- Reasons for choosing
- Best features of

IV. Changes Occurring and Desired

- Changes noted and effects of those changes
- Changes desired

V. Perceptions of Use Levels and Conflicts

- Number of boats expected to see while boating
- Number of boats preferred to see while boating
- Problems/conflicts with other boaters

VI. Additional Comments

- General comments, suggestions, continuation of responses to open-ended questions, or comments on issues not covered (**Appendix D**)

2.9 Sampling Limitations

1. No public boat ramp could be sampled more than five times during the twelve week period.
2. All high-use public boat ramps must have at least one on-site interview conducted at the site.
3. All weekdays were treated equally for sampling purposes.
4. On-site interviews were conducted for all weekend days.

2.10 Data Analysis

All survey data were entered into SPSS™, a statistical software package for analysis. The count data from the maps were stored and graphically displayed using ArcMap™ software, a Geospatial Information System (GIS). Statistical analysis techniques were used to summarize all boater responses.

2.11 Management Compartments

Management Compartments are a reconfiguration of the lake service areas. They are based on analysis of survey data, boat count data, and managers' perceptions of lake use. Their purpose is to facilitate the formation of management strategies designed to maintain the desired conditions for specific recreation experiences. They account for resource, management, physical and social conditions. Physical conditions include coves, bends in the lake, submerged tree stumps, and wide and narrow expanses of water; Social conditions address the boating opportunity provided along with the amount and type watercraft, traditional use patterns, and emerging trends; Management conditions address control issues in terms of the ability to apply education and enforcement options. The purpose of establishing management compartments is to facilitate the formation of management strategies designed to maintain the desired condition for specific recreational experiences in a given area.

Classifying the lake into categories for the purpose of directing future desired conditions is accomplished by combining boat traffic density and conflict data.

2.11.1 Boat Traffic Density

Boat traffic density is a measurement of the available water surface per boat in an area. This density data was gathered by recording all boats on the water during peak use periods, which were from 1:00PM to 3:00PM. The lake was divided into boat count "zones" that permit the recording on-the-water boats within a two-hour time period. The location and type of craft are recorded onto a map.

Table 6. Boat Traffic Density

Use Level	Density
Very High	< 10.0 acres/boat
High	10.0 – 15.0 acres/boat
Moderate	15.1 – 20.0 acres/boat
Low	20.1 – 25.0 acres/boat
Very Low	> 25.0 acres/boat

A boat traffic density table was developed based on over 30 boating capacity studies as a guideline to compute acres per boat (**Table 6**). A condition where acres per boat are less than 10 is considered a threat to safety and enjoyment.

2.11.2 Conflict Data

A "conflict" is an area, as perceived by the user, that the user avoids or considers unsafe. Conflict data are gathered by inputs provided by lake users in both the exit ramp surveys and the mail surveys. Lake users are asked to identify and rank areas on the lake that they consider places to avoid or are unsafe. These areas are considered "areas of conflict."

2.12 Incidence of Conflict and Boater Density

Conflict information was gathered by showing boaters a map of the lake and asking them to identify avoided and unsafe locations. A three step process was used to compute conflict categories. 1) The number of avoided and unsafe locations within one compartment were divided by the total of avoid and unsafe locations on the entire lake. 2) Categories of conflict were then computed from the data using percentiles as follows: Upper 66%, Middle 33-66%, and Lower 33% percentiles. 3) These three categories of conflict were labeled based on the following percentages that were derived by the limits established with those percentiles: high > 3.93%, moderate 1.21 – 3.93%, and low < 1.21%.

Boat traffic density is a calculation of the amount of surface water available for each boat. This information is derived from the boat count data. A correlation exists between traffic density and boater conflict. As boat traffic density increases, so does the percent of conflicted areas within a management compartment. Ten acres per boat is the density figure used by lake and reservoir managers as a threshold beyond which a body of water is "high" on the conflict scale and considered "overcrowded". The matrix below characterizes use level categories and conflict criteria on the basis of boater density (**Table 7**).

Table 7. Characterization of Use Level and Conflict Criteria Based on Boater Density

Conflict Scale		Density Criteria (Surface water/boat)	Use Level Category
<1.21%	Low	>25 acres	Very Low
1.21-3.93%	Moderate	20-25 acres	Low
>3.93%	High	15-20 acres	Moderate
		10-15 acres	High
		<10 acres	Very High

2.13 Geospatial Information System (GIS) and Boating Capacity

A Geospatial Information System (GIS) is a computer application that provides specialized digital mapping. Data collected during the summer of 2009 at Table Rock Lake was used to develop classification maps for lake managers to consult. Each dataset was mapped using GIS to allow easy visualization of conflict and boat traffic density. ArcMap™ and Microsoft Excel™ were the main software used in analysis.

Conflict data was collected by utilizing information from the mail-back surveys and exit interviews at boat ramps. Conflict maps were developed that show the location of areas that boaters considered their favorite, unsafe, or avoided areas (**Figures 4 and 5**, Page 41-42). These maps were used to develop a conflict rating for each management compartment.

Conflict percentages were derived from responses from boaters surveyed. "Avoided" and "unsafe" responses were regarded as areas of conflict, while "favorite" responses were not. Percentages for each management compartment were found by finding the percent of conflicted responses to the total number of responses for each management compartment.

Boat density was determined from scheduled boat counts. The lake was divided into eight zones. Data collectors made two counts in each zone, one time each on weekdays and one time each on weekends. A Count was also conducted on July 3 for the Independence Day holiday weekend. The location and type of each boat were documented on maps by hand. The data provided on these maps were then transferred to GIS.

After the average number of boats per management compartment was found, they were divided by the acres per compartment to find acres per boat. Density levels were determined by using this information.

To find the final classification for each management compartment, density levels and conflict levels were looked at in combination. Classifications were based on the following matrix (**Table 8**).

Table 8. Time Period Influence on Maps A & B

Time Period	Weighted Influence
	Maps A & B
Weekdays (1 day per zone)	52.43% (54/103 total days)
Weekends (1 day per zone)	47.57% (49/103 total days)
July 3	1%

Management compartment density was found in two ways, first using only non-event (e.g. non-holiday) survey days then using all survey days. Map A uses only data from scheduled counts (excludes July 3), whereas Map B uses data from the scheduled counts as well as July 3. Overall, weekend days contributed 47.57% and weekdays contributed 52.43%; July 3rd contributed 1%. Map A (**Appendix F, Figure 6**) is presented as the recommended map for TRL while Map B (**Appendix F, Figure 12**) is provided for consideration.

The final classification for each management compartment was determined by examining the density levels and conflict levels in combination. After classifications were found, maps were developed for each scenario (Maps A and B), including maps based on projected increases in density (20%, 40%, 60%, 80%, and 100%). Map projections are found in **Appendix F, Figures 7-11 and 13-17**. The management compartment classifications are listed in **Table 9**.

Table 9. Management Compartment Classification

	Existing Boating Conditions	Management Objectives
Class I	Moderate to very high boat traffic density at peak use times and high to very high incidence of conflict	No new development is recommended since it may worsen the conditions for safety and enjoyment. Greater law enforcement, boating patrol, and education are necessary.
Class II	Moderate to high boat traffic density at peak use times and moderate to very low incidence of conflict	Consideration of new development is possible in combination with management and resource factors.
Class III	High to very high boat traffic density at peak use times but low incidence of conflict	Since conditions are often characterized by stationary boats located in sheltered "escape coves" it is important to protect these opportunities and no development is recommended.
Class IV	Low or very low boat traffic density, even at peak use times, and low incidence of conflict	No development is recommended to protect low density/low conflict or pristine experiences on the water.

2.14 On-The-Water Boat Counts

Boat counts were conducted from a boat traveling the length of a zone. All counts were done from 1:00PM to 3:00PM on the scheduled day.

2.15 Count Method and Routes

The boat was driven through the length of the zone, while a dedicated observer marked on a map the location of boats on the lake. The location and boat type was noted for each observed boat.

The count boat went into coves only as far as necessary to see all the boats present. Field glasses were used to see distant boats. An effort was made to progress down the lake as fast as possible while still allowing the necessary observations to be made in order to minimize the number of double counts.

The data observed during each count was tallied later from the maps. The count data from the maps were stored and graphically displayed using ArcMap™ and Microsoft Excel™ software (**Appendix G**).

2.16 Limitations of Count Method

Conducting counts from the water has advantages and disadvantages as compared with aerial photography. An aircraft-mounted camera can be used to take photograph of large portions of the lake in close sequence. Therefore, aerial photographs provide the possibility for accurate counts that are near to being "snapshots" of conditions at a particular time. Since each on-the-water count takes several hours to complete and because boats move about and may enter or leave the zone during that time, on-the-water counts do not offer a "snapshot" count.

An advantage of on the water counts is that each boat can be categorized into type. Additionally, boat counts are not operationally hindered by overcast weather conditions and are much less expensive. Aerial photographs are not clear enough to differentiate boats into type.

Although every effort was made to minimize count errors, there is an increasing possibility they will occur as the number of boats on the lake increases. For example, boats already counted and moving down the lake in the same direction as the count boat may be double counted. Also, some boats may be missed due to congestion of certain areas of the lake. In general, these errors should balance each other out. Though an absolutely exact count cannot be claimed for peak use periods (i.e., weekend afternoons) when errors are most likely to occur, the counts are estimated to be within +/- 5% of the actual number of boats present.

3.0 Results

3.1 Introduction

A wide variety of baseline information about the boaters utilizing the lake was obtained through this study. Though a nearly inexhaustible series of analyses can be done on the survey data, we have chosen to present this information in the form of averages and grouped responses. We believe this allows for the most immediate and accessible presentation of information and is sufficient to expand understanding of current conditions. The data collected in this survey provide a baseline of information from which to draw conclusions about current conditions, and with which to compare future changes. Using similar survey methods, subsequent monitoring, would allow for tracking of trends in use patterns and perceptions of conditions.

Each of these pieces of information helps describe and differentiate the various boater populations that use the lake. The reason for collecting each type of information and its potential usefulness to managers is described prior to the discussion of survey data. The intent is to "paint a picture" of the boater populations on the lake and facilitate understanding of their make-up and activity.

The boater survey results are presented in three parts after a discussion of survey response rates. Presented first are the descriptive data that explain who the boaters are on the lake in terms of length of boaters experience, frequency of use, distance traveled, group size, duration of visit, boat size, and activities participated in on the lake. The second part presents boaters' perceptions about the quality of their recreational experience, location preferences, safety and crowding issues, and preferences regarding natural resource, social, and managerial conditions. The third part summarizes the boat count results to provide additional information regarding boat type, distribution, and boat density.

3.2 Survey Response Rates

3.2.1 Mail-back Surveys

A 66% return rate was achieved with the mail survey of marina slip renters, slip owners, and shoreline residents, (the "mail-back survey respondent" group). This figure excludes mailings that were "return to sender." Addresses were re-checked for accuracy on all undelivered questionnaires. Response rates should achieve close to 50% as a requirement for sound science. For controversial studies, a check for non-response bias would improve this requirement.

3.3 Boater Descriptions

3.3.1 Length of Boaters' Experience

In the visitor perception portion of the survey, respondents were asked about present conditions and changes that have occurred at the lake. The amount of knowledge boaters have about these topics (the data on which are presented later in this report) depends greatly on their length of boating experience on the lake. Boaters' length of experience also determines the time frame in which they have observed changes. Previous studies at lakes regulated by the USACE and TVA have shown that long-time visitors often develop a sense of "ownership" of a lake, and tend to have a greater sensitivity to and concern about changes at the property than do visitors with less experience (Titre and Vogel 1993).

Boaters were asked to report the number of years they have been visiting the lake. Nearly all respondents had boated before 2009; only 1.4% of mail-back survey respondents were visiting for the first time. Thirty-two percent of ramp users and 14% of mail-back survey respondents had only one to five years of experience on the lake (**Table 10**), while the majority of ramp (39%) and mail-back survey respondents (50%) had more than 16 years.

Table 10. Length of Experience

	Ramp Avg. yrs. of experience=		**Marina/Slip/Land Owner** Avg. yrs. of experience=	
Length of Experience	**#**	**%**	**#**	**%**
Boated at lake before	n/a*	n/a*	643	96.7
This is first year	1	0.3	9	1.4
1-5 years	110	32.0	89	14.3
6-10 years	60	17.4	129	20.7
11-15 years	38	11.0	83	13.3
16+ years	135	39.2	312	50.2
Total	**357**	**100**	**622**	**100**

*sample size of respondents too small to report.

3.3.2 Frequency of Use

Boaters who visit the lake frequently are more familiar with current conditions than boaters who visit less frequently. They are likely to be more affected by detrimental changes in their recreational experience at the lake than are individuals who distribute their water-based recreation activities over several lakes. For the purpose of comparison, boaters can be divided into four frequencies of use categories:

"Occasional" visitors.....1-10 days per year
"Regular" visitors.....11-30 days per year
"Frequent" visitors.....31-50 days per year
"Very frequent" visitors.....>50 days per year

Both boater groups visited the lake primarily on weekends. Most ramp users (31%) were "very frequent" visitors on weekends, followed by "occasional" (30%). None of the respondents reported zero days on week days while only one respondent reported zero days on weekends (**Table 11**).

Table 11. Frequency of Use in 2009

	Ramp			
	Weekend Days		Week Days	
Days Spent	**#**	**%**	**#**	**%**
0 days	1	.4	0	0
1-10 days	69	29.6	24	24.5
11-30 days	60	25.8	25	25.5
31-50 days	31	13.3	9	9.2
More than 50 days	72	30.9	40	40.8
Total	**233**	**100**	**98**	**100**

3.3.3 Distance Traveled

The distance boaters live from the lake affects how frequently they use the lake. This is also a factor in how boaters may be reached for educational efforts, and influences the likelihood that they will participate in public meetings to provide their input on management issues. Boaters were asked about the city and state of their residence and the distance traveled was calculated from this information. Nearly all boaters surveyed reside in Missouri; the largest portions of both groups (36% of the ramp users and 38% of the mail-back respondents) live within 30 miles or less of the lake (**Table 12**).

Table 12. Distance Traveled

	Ramp		Marina/Slip/Land Owner	
Distance Traveled	**#**	**%**	**#**	**%**
Less than 30 miles	124	36.3	228	37.6
30- 59 miles	105	30.7	146	24.1
60-89 miles	17	5.0	17	2.8
90 miles or more	96	28.1	215	35.5
Total	**342**	**100**	**606**	**100**

3.3.4 Size of Group on Most Recent Visit (Ramp Users)

Ramp users were asked about the number of people in their party the day of the interview. Thirty-four percent of those surveyed were visiting in groups of one to two persons (**Table 13**).

Table 13. Size of Group on Most Recent Visit (Ramp Users)

Group Size	**#**	**%**
1-2 persons	120	33.9
3-4 persons	122	34.5
5-6 persons	57	16.1
More than 6 persons	55	15.5
Total	**357**	**100**

Average number of persons in group = 3

3.3.5 Duration of Most Recent Visits

The duration of each boater's visit is a basic component of visitor descriptions. Previous studies have shown that the duration of visits are related to the frequency of visits and the distance traveled to the lake. Boaters who traveled greater distances typically visited less often, but remained longer. Most ramp users (47%) spent an average of four to six hours on the lake; the mail-back respondents were similar as the majority of their visits lasted four to six hours (51%) or longer (17%). The vast majority of both user groups spent more than two hours on the lake (**Table 14**). This is consistent with other boating capacity studies.

Table 14. Duration of Most Recent Visit

	Ramp Avg hours =		**Marina/Slip/Land Owner** Avg hours =	
Time Spent	**#**	**%**	**#**	**%**
Less than 2 hours	30	8.5	16	5.1
2- 4 hours	82	23.3	85	26.9
4-6 hours	165	46.9	161	50.9
More than 6 hours	75	21.3	54	17.1
Total	**357**	**100**	**316**	**100**

3.3.6 Type, Length and Horsepower of Boats Used

The type of boats being used by each group provides an indication of their boating activity. Visitors who use runabouts, pontoon boats, or sailboats can be expected to use the lake differently than other visitors. Differences include the speed and distance traveled preferred areas, and the type of activity they engage in. Furthermore, visitor conflicts are related to the type of watercraft being used. Previous studies have revealed frequent conflicts between small fishing boats and runabouts. Tracking changes in the types, sizes, and power of boats being used will allow managers to anticipate changes in use patterns and increases in conflicts among boater types.

The majority of ramp users typically used runabouts (39%) followed by fishing boats (33%) while most mail-back respondents preferred runabouts (40%) followed by pontoon boats (23%). Mail-back survey respondents also preferred larger boats with more horsepower (an average of 23 feet and 217 horsepower) than ramp users (an average of 19 feet and 171 horsepower). Mail-back respondents had the highest percentage of boats with more than 200 horsepower (**Table 15**).

Table 15. Type, Length and Horsepower of Boats Used				
	Ramp		Marina/Slip/Land Owner	
	#	%	#	%
Runabout/Speedboat/Ski Boat	139	37.1	261	39.6
Fishing Boat/Bass Boat	116	30.9	84	12.7
Pontoon Boat	47	12.5	149	22.6
Personal Watercraft	47	12.5	61	9.3
High Performance Boat	6	1.6	7	1.1
Houseboat	4	1.1	33	5.0
Cabin Cruiser	3	.8	41	6.2
Rowboat/ Canoe	2	.5	1	.2
Sailboat/ Sailboard	1	.3	10	1.5
Other	10	2.7	12	1.8
Boat Size				
Average length (feet)	19.4		23.4	
<16 feet	43	12.6	6	1.6
16-20 feet	182	53.2	130	34.9
21-30 feet	110	32.2	200	53.6
31-40 feet	4	1.2	11	2.9
>40 feet	3	.9	26	7.0
Boat Horsepower				
Average HP	171.0		217.4	
<51 HP	35	11.2	57	9.7
51-100 HP	56	17.9	106	18.0
101-200 HP	141	45.0	196	33.3
201-300 HP	57	18.2	140	23.8
301-400 HP	24	7.7	90	15.3

3.3.7 Boaters' Activities

The types of activities boaters participate in are a good indicator of the conditions they desire. For example, boaters participating in water-skiing or similar water sports may desire different physical and social conditions than boaters interested in fishing or cruising. Both boating groups were asked what types of activities they engaged in, and the amount of time they spent doing each activity during their most recent visit to the lake. For ramp users, cruising was the predominant activity, followed by swimming, fishing, relaxing, other, and skiing. Most mail-back survey respondents were cruising followed by swimming, relaxing, fishing, skiing, and other. Other activities listed by boaters included wakeboarding and tubing (**Table 16**).

Table 16. Boaters' Activities				
	Ramp		Marina/Slip/Land Owner	
Activity	**#***	**%***	**#***	**%***
Cruising	159	25.0	543	26.5
Fishing	127	20.0	304	14.9
Swimming	133	20.9	432	21.1
Water skiing	60	9.4	245	12.0
Relaxing	80	12.6	412	20.1
Other Activities	76	12.0	110	5.4

* For each user group, the number and percentage columns describe how many people responded as participants in each activity.

3.4 Boaters' Perceptions

Visitor descriptions portray how people are using the lake, but these descriptions are broad because boaters often engage in several activities during the same trip. There is much diversity in how each activity is pursued and the conditions boaters' desire for that activity. For example, some boaters may swim and sunbathe at designated swim areas so that they can be near people and make acquaintances, others visitors may seek solitude for the same activities. Differences in the way people pursue the same activity suggest that we must look beyond simple visitor descriptions.

Descriptive information alone is not sufficient to make defensible management decisions. This type of information becomes most useful when it is linked to boaters' responses about their perceptions of and preferences for conditions given in the second portion of the survey. The descriptive data is used to connect boaters' statements about conditions to specific types or groups of boaters. Knowing such things as the extent of boaters' experience at the lake, how much they use the lake, the types of watercraft they use, and the water-based activities they participate in helps explain their perceptions and preferences. Both types of information are necessary to reach an understanding of what boaters are looking for at the lake and how those recreation opportunities may be protected and improved. The following section presents summarized results of boaters' perceptions. A list of coded responses to open-ended questions for ramp users at the lake is provided in **Appendix D**. A list of coded responses to open-ended questions for mail-back survey respondents at the lake is provided in **Appendix D**.

Conflict percentages were derived from responses from boaters surveyed. "Avoided" and "unsafe" responses were regarded as areas of conflict, while "favorite" responses were not. Percentages for each management compartment were found by finding the percent of conflicted responses to the total number of responses for each management compartment (**Figures 4 and 5**).

Figure 4. Favorite, Avoid, and Unsafe Locations among Ramp Users on Table Rock Lake

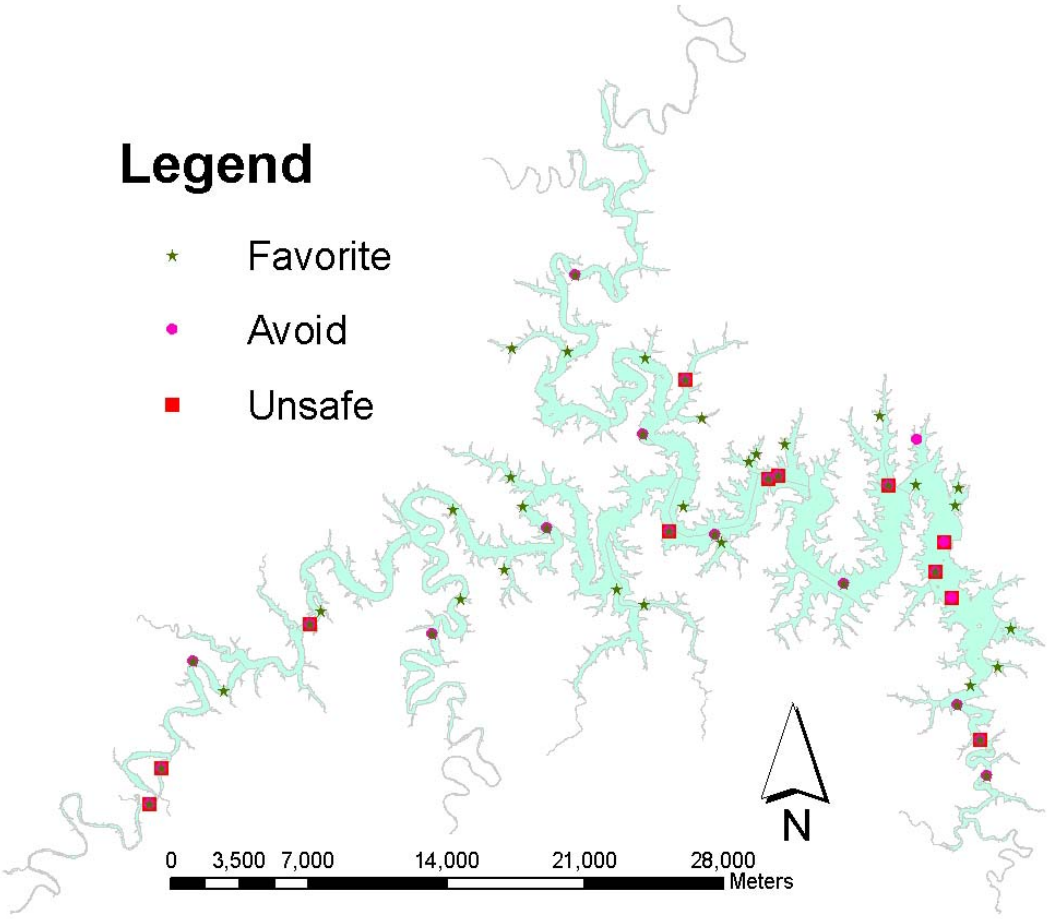
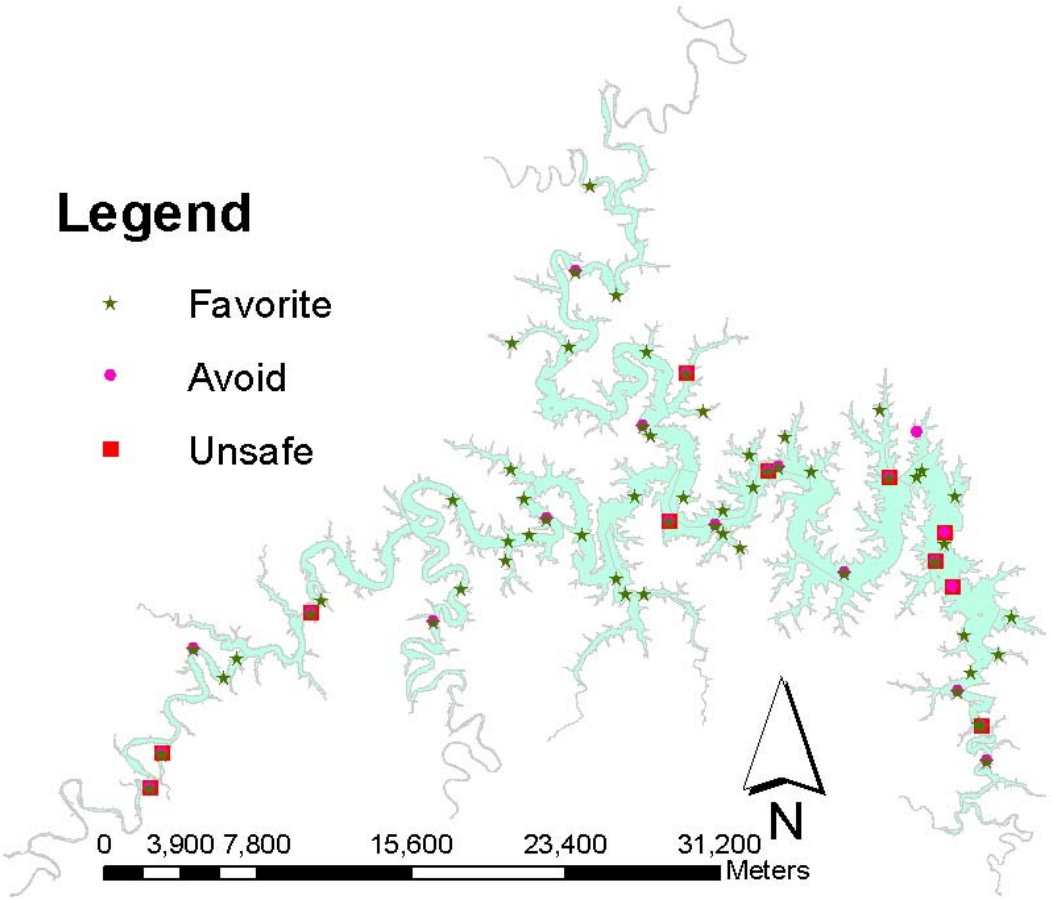


Figure 5. Favorite, Avoid, and Unsafe Locations among Marina, Slip, and Land-Owner Users on Table Rock Lake



3.4.1 Boaters' Favorite Locations

Identifying favorite locations and the characteristics that distinguish them reveal the conditions boaters considered most desirable. These locations provide the recreational setting for enjoyable boating experiences on the lake. Respondents were asked to identify two favorite locations, the five most frequently cited locations for each group are presented in **Table 17**, and a comprehensive list of responses is provided in the appendices.

Table 17. Boaters' Favorite Location					
Ramp	**#**	**%**	**Marina/Slip/Land Owner**	**#**	**%**
Cape Fair	20	27.4	Cow Creek	49	39.2
Aunts Creek	18	24.7	Long Creek	22	17.6
Viola	15	20.5	Campbell Point	19	15.2
Baxter	11	15.1	Mill Creek	18	14.4
State Park	9	12.3	Baxter	17	13.6
Total	**73**	**100**		**125**	**100**

*Frequencies above are inclusive of both of the two favorite locations marked by respondents.

3.4.2 Attributes of Favorite Locations

Among mail-back survey respondents, the most frequent attribute of favorite locations was convenience or near home followed by enjoying solitude, quiet, and fewer boats. A much larger majority of mail-back survey respondents choose their favorite locations on the basis of convenience. The attributes of favorite places on the lake are provided in (**Table 18**).

Table 18. Attributes of Favorite Locations				
Attribute	**Ramp**		**Marina/Slip/ Land Owner**	
Social Conditions	**#**	**%**	**#**	**%**
Solitude, relaxing, quiet, fewer boats	68	19.8	192	23.1
Hang out with friends	9	2.6	25	3.0
Physical Resource Conditions				
Close, convenient, familiar, own a home there	73	21.2	231	27.8
Good fishing	57	16.6	85	10.2
Natural resource features; wildlife; undeveloped shoreline; scenery	36	10.5	72	8.7
Smooth water, calm water, open water	38	11.0	62	7.5
Water quality	5	1.5	9	1.1
Facility or Activity-Related Conditions				
Good skiing, wake-boarding, cruising or swimming	20	5.8	50	6.0
Good facilities	38	11.0	106	12.7
Total	**344**	**100**	**832**	**100**

3.4.3 Locations Boaters Avoid

The locations avoided by boaters are an indication of the circumstances detrimental to their recreation experiences. As avoided locations become more numerous, the quality of boaters' recreational experiences is diminished. Each group mentioned several locations that they avoid on the lake. The locations boaters avoided on the lake are provided in **Table 19**.

Table 19. Locations Boaters Avoided

	Ramp		Marina/Slip/ Land Owner	
Location*	**#**	**%**	**#**	**%**
Kimberling City	38	38	56	42.1
Dam	37	37	59	44.4
Main Channel	12	12	7	5.3
State Park	8	8	6	4.5
Aunts Creek	5	5	5	3.7
Total	**100**	**100**	**133**	**100**

*Respondents were asked to identify two avoided locations.

3.4.4 Attributes of Locations Avoided

Although the areas that boaters avoid are varied, the attributes of those locations are not; both user groups frequently avoided crowded areas and rough water (**Table 20**).

Table 20. Attributes of Locations Avoided by Boaters

Attribute	**Ramp**		**Marina/Slip/ Land Owner**	
Social Conditions	**#**	**%**	**#**	**%**
Crowding: too many boats, people, or traffic	89	58.9	166	60.6
Unsafe boating behavior	10	6.6	16	5.8
Alcohol consumption	7	4.6	12	4.4
Physical Resource Conditions				
Rough water, too many wakes	32	21.2	51	18.6
Water characteristics: shallow, deep water	6	4.0	9	3.3
Water hazards: floating debris, logs, stumps	4	2.7	16	5.8
Facility or Activity-Related Conditions				
Conditions of Facilities	3	2.0	4	1.5
Total	**151**	**100**	**274**	**100**

3.4.5 Boaters' Perceptions of Safety during Most Recent Visit

Boaters' perceptions of safety were also polled with several survey questions, users were asked to identify where they felt unsafe on a map, describe the attributes of those locations, and rate how safe they felt on a scale of 1 – 5. **Table 21** reports the three most frequently cited unsafe locations. A comprehensive list for each group is provided in the appendices. Too much traffic followed by water conditions/obstructions were the most frequently cited hazards by ramp and mail-back survey respondents respectively; mail-back survey respondents were the most sensitive to social conditions such as crowding and boat behavior (**Table 22**). Although boaters reported avoiding certain areas of the lake due to safety concerns such as water hazards and too many boats, the majority of boaters felt "moderately" or "extremely safe" on their most recent visit to the lake (**Table 23**). At the current level of recreation usage, boaters are able to find areas on the lake where they feel safe. However, the open-ended comments about unsafe and avoid areas identifies problem areas on the lake that are specific to safety concerns for management.

Table 21. Locations Considered Unsafe by Boaters

	Ramp		Marina/Slip/ Land Owner	
Location*	**#**	**%**	**#**	**%**
Kimberling City	12	34.3	23	40.3
Dam	11	31.4	13	22.8
Highway 13	5	14.3	14	24.6
Main Channel	4	11.4	4	7.0
Aunts Creek	3	8.6	3	5.3
Total	**35**	**100**	**57**	**100**

*Respondents were asked to identify two unsafe locations.

Table 22. Attributes of Locations Considered Unsafe by Boaters

Attribute	**Ramp**		**Marina/Slip/ Land Owner**	
Social Conditions	**#**	**%**	**#**	**%**
Too many boats, people or traffic	22	47.8	77	44.3
Unsafe boating behavior	2	4.4	29	16.7
Other social conditions, alcohol abuse	2	4.4	11	6.3
Physical Resource Conditions				
Water conditions	14	30.4	30	17.2
Water obstructions	6	13.0	27	15.5
Total	**46**	**100**	**174**	**100**

Table 23. Boaters' Perception of Safety During Most Recent Visit				
	Ramp		Marina/Slip/ Land Owner	
Perception	**#**	**%**	**#**	**%**
Not safe at boat ramp	1	.3	8	1.8
Somewhat safe at boat ramp	6	1.8	9	2.1
Moderately safe at boat ramp	47	13.7	89	20.4
Extremely safe at boat ramp	288	84.2	330	75.7
Total	**342**	**100**	**436**	**100**
Not safe on water	0	0	10	1.6
Somewhat safe on water	9	2.6	21	3.5
Moderately safe on water	67	19.2	180	29.9
Extremely safe on water	273	78.2	392	65.0
Total	**349**	**100**	**603**	**100**

3.4.6 Changes Boaters Have Noticed

Lake users are a good source of information regarding changes occurring at the lake (**Tables 24 and 25**). Many visitors have several years of experience on the lake and are keenly aware of changes that affect their recreational experience. Cleaner water followed by cleaner area (less garbage) and increased water patrol were the most frequently cited positive changes by both groups; boating traffic followed by bigger boats were the most frequently cited negative changes by mail-back survey respondents. Ramp users frequently noticed boating traffic followed by dirty water as negative changes.

Table 24. Changes Boaters Have Noticed		
	Ramp	Marina/Slip/ Land Owner
Negative Changes	#	#
Boat traffic worse (more crowded, more people)	29	91
Bigger boats	12	62
Dirty water (not as clear)	28	28
Too much development/construction	4	8
Camping/picnic sites (not enough or not well kept)	5	9
Positive Changes		
More water patrol	4	21
Cleaner area	7	24
Cleaner water	11	26
More docks	5	27
Fishing better	11	9

Table 25. Boaters' Perceptions of Facilities												
	Ramp						Marina/Slip/Land Owner					
	About Right		Need More		Too Many		About Right		Need More		Too Many	
Facility	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Parking Areas	237	67.5	113	32.2	1	.3	399	72.0	130	23.5	25	4.5
Boat Ramps	250	72.3	95	27.5	1	.3	423	75.0	118	20.9	23	4.1
Marinas	290	85.3	41	12.1	9	2.6	444	77.5	104	18.2	25	4.4

3.4.7 Boaters' Perception of Crowding During Most Recent Visit

Table 26 illustrates boaters' response to questions about crowding. The majority of ramp users (79%) and mail-back survey respondents (41%) perceive the lake as not crowded. A substantially higher percentage of mail-back survey respondents reported feeling moderately or extremely crowded.

Table 26. Boaters' Perception of Crowding During Most Recent Visit				
	Ramp		Marina/Slip/Land Owner	
Crowding	**#**	**%**	**#**	**%**
Not crowded	271	78.8	247	41.4
Somewhat Crowded	32	9.3	187	31.3
Moderately crowded	23	6.7	130	21.8
Extremely crowded	18	5.2	33	5.5
Total	**344**	**100**	**597**	**100**

3.4.8 Boaters' Additional Open-Ended Comments

Boaters were asked at the end of the survey if they had any additional comments (**Table 27**). The most frequent responses among ramp users were related to the need for facilities improvements and to reduce fees (n=90 users), followed by "boats are too big," unsafe boating behavior/PWC concerns, and great place/scenery/good fishing. Mail-back survey respondents also most frequently cited facilities needing improvement and reducing fees (n=43 users) followed by great place scenery, "boats are too big," and unsafe boating/PWC concerns.

Table 27. Boaters' Additional Comments		
	Ramp	**Marina/Slip/Land Owner**
Social Conditions	#	#
Solitude, not crowded	1	0
There are more boats and traffic	6	13
Unsafe boating behavior, PWC concerns	10	26
Boats are too big	13	28
Physical Resource Conditions		
Need better fishing	4	3
Great place, scenery, good fishing	10	29
Lake is clean	1	1
Water quality decline, lake level fluctuations	4	15
Limit shoreline development	2	11
Facility or Managerial Conditions		
Facilities are good	2	6
Facilities need improvement; reduce fees	90	43
Need more rule enforcement & patrol	4	12
Too much enforcement & patrol	0	11

3.4.9 Differences among Boater Craft Types in Crowding, Safety, and Facility Needs

To provide a managerial understanding, a series of independent sample t-tests were conducted with the ramp and mail-back survey respondent data combined. Fishing/Bass boaters (M=2.05) were significantly lower than those boating other craft types (M=2.14) in their perceptions of the need for more ramps (t=2.75, df=907, p=.006). Pontoon boaters felt significantly safer on the water (M=3.54, df=948, t=2.68, p=.008) than boaters in other craft types (M=3.67). Those boating in cabin cruisers were significantly higher in their perceptions that more marinas were needed (M=2.42, df=907, t=-4,46, p=.000) as opposed to boaters of other craft types (M=2.11). Other than the findings reported above, no other significant differences were found in crowding and safety perceptions or facility needs among boaters of different craft types.

3.4.10 Correlations among Crowding, Safety, and Facility Need Perceptions

A significant negative correlation was found between feeling safe at boat ramps and feeling crowded at ramps (r=-.155, p<.001). Furthermore, a significant negative correlation was found between feeling safe on the water and feeling crowded on the water (r=-.297, p<.01). Feeling crowded at ramps was also significantly correlated with the need for more boat ramps (r=.240, p<.01) and parking areas (r=.266, p<.01). Similarly, perceptions of crowding on the water at Table Rock Lake were significantly correlated with the need for more ramps (r=.130, p<.05), parking areas (r=.115, p<.05) and marinas (r=.122, p<.05). Finally, feeling safe on the water was significantly correlated with the need for more adequate parking areas.

3.5 Classification Chart

Table 28 exhibits the classifications of management compartments for Maps A and B. Overall Map A and Map B demonstrated similar classifications of management compartments. With the exception of Viney-Big M, Maps A and B shared identical classifications of management compartments for Class I-IV rankings. For Maps A and B, Class I management compartments included Cricket Creek Marina, Long Creek Marina, Dam-State Park, DD Highway, Kimberling City, South Joe Bald, Aunt's Creek, Swings, and Cape Fair. For Map A, Viney-Big M was ranked as Class I. For the Class I management compartments, density levels were all high to very high and conflict levels were all medium to high.

Class II management compartments included Joe Bald, Lower White, Shell Knob-Campbell Point, Central White, and Holiday Island. For the Class II management compartments, density levels were all very low to medium and conflict levels were all low to high suggesting much more variation in density and conflict levels.

The majority of management compartments were ranked as Class III. These compartments included Cricket Creek, Brushy Creek, Big Cedar Cove, Persimmon Cove, Clevenger Cove, Beardsley Cove, Back of Jake's Branch, Jake's Creek, Little Cow/Big Cow - Spring Branch, Indian Point Harbor-Marina, White's Branch, Gohr Hollow, Little Aunt's Creek, Lower James, Baxter, Three Fingers, Shell Knob-Campbell Point, Upper white, and Eagle Rock Marina. Viney-Big M was ranked as Class III for only Map B. Density for the Class III management compartments ranged from high to very high while conflict was low.

Class IV management compartments included Yocum-Long Creek, Mid James, Piney Creek Wilderness, Flat Creek, Upper James, Kings River, White Headwaters, and Beaver Dam Tailwaters. Density ranged from very low to low and conflict was low for the Class IV management compartments.

Table 28. Table Rock Lake Classification Chart for Maps A & B										
Compartment ID	**Compartment Name**	**Acres/ Boat Map A**	**Acres/ Boat Map B**	**Density Level**	**Conflict - Map A**	**Conflict - Map B**	**Conflict Level A**	**Conflict Level B**	**Class Map A***	**Class Map B***
01	Yocum-Long Creek Split	33.84	33.84	L	0.00	0.00	L	L	IV	IV
02	Cricket Creek	6.37	6.37	VH	0.00	0.00	L	L	III	III
03	Cricket Creek Marina	3.56	3.56	VH	3.00	1.79	M	M	I	I
04	Brushy Creek	2.66	2.66	VH	0.00	0.00	L	L	III	III
05	Long Creek Marina	2.86	2.86	VH	5.00	2.68	H	M	I	I
06	Big Cedar Cove	1.82	1.82	VH	0.00	0.00	L	L	III	III
07	Persimmon Cove	2.54	2.54	VH	0.00	0.00	L	L	III	III
08	Clevenger Cove	3.53	3.53	VH	0.00	0.00	L	L	III	III
09	Beardsley Cove	2.54	2.54	VH	0.00	0.00	L	L	III	III
10	Back of Jake's Branch	6.05	6.05	VH	0.00	0.00	L	L	III	III
11	Jake's Creek	3.47	3.47	VH	1.00	0.45	L	L	III	III
12	Dam-State Park	5.19	5.19	VH	73.00	39.73	H	H	I	I
13	Little Cow-Big Cow-Spring Branch	5.67	5.67	VH	0.00	0.00	L	L	III	III
14	Indian Point Harbor-Marina	7.72	7.72	VH	0.00	0.00	L	L	III	III
15	White's Branch	4.04	4.04	VH	0.00	0.00	L	L	III	III
16	DD Highway	12.58	12.58	H	8.00	4.91	H	H	I	I
17	Gohr Hollow	8.13	8.13	VH	0.00	0.00	L	L	III	III
18	Kimberling City	8.83	8.83	VH	51.00	24.55	H	H	I	I
19	South Joe Bald	10.28	10.28	H	19.00	10.27	H	H	I	I
20	Joe Bald	19.63	19.63	M	0.00	0.00	L	L	II	II
21	Little Aunt's Creek	4.21	4.21	VH	0.00	0.00	L	L	III	III
22	Aunt's Creek	7.50	7.50	VH	8.00	4.02	H	H	I	I
23	Swings	1.40	1.40	VH	8.00	4.46	H	H	I	I
24	Lower James	12.78	12.78	H	0.00	0.00	L	L	III	III
25	Buttermilk-Hideaway	19.86	19.86	M	0.00	0.00	L	L	II	II
26	Mid James	25.07	25.07	VL	0.00	0.00	L	L	IV	IV
27	Piney Creek Wilderness	23.13	23.13	L	0.00	0.00	L	L	IV	IV
28	Cape Fair	12.13	12.13	H	2.00	1.34	M	M	I	I
29	Flat Creek	100.18	100.18	VL	0.00	0.00	L	L	IV	IV
30	Upper James	41.82	41.82	VL	0.00	0.00	L	L	IV	IV
31	Baxter	12.69	12.69	H	0.00	0.00	L	L	III	III
32	Lower White	19.86	19.86	M	0.00	0.00	L	L	II	II
33	Big Creek	12.76	12.76	H	0.00	0.00	L	L	III	III
34	Three Fingers	14.20	14.20	H	0.00	0.00	L	L	III	III
35	Shell Knob-Campbell Point	19.18	19.18	M	3.00	1.79	M	M	II	II
36	Kings River	20.94	20.94	L	1.00	0.45	L	L	IV	IV
37	Central White	15.50	15.50	M	0.00	0.00	L	L	II	II
38	Viney-Big M	6.06	6.06	VH	2.00	0.89	M	L	I	III
39	Upper White	10.70	10.70	H	0.00	0.00	L	L	III	III
40	Eagle Rock Marina	14.84	14.84	H	0.00	0.00	L	L	III	III
41	White Headwaters	21.36	21.36	L	1.00	0.45	L	L	IV	IV
42	Holiday Island	42.81	42.81	VL	5.00	2.23	H	M	II	II
43	Beaver Dam Tailwaters	32.27	32.27	VL	0.00	0.00	L	L	IV	IV

***** Classes for Map A and Map B are described in **Table 9**.

4.0 Discussion

4.1 Management Information Obtained

Much has been learned during this study about how much and how often boaters use the lake. The characteristics of boaters are closely related to how they react to observed changes occurring on the lake and what they perceive to be quality recreational opportunities. A wide variety of survey generated baseline information about boater groups describes their perceptions about and preferences for the conditions that most affect their use and enjoyment of the lake.

4.1.1 Boater Descriptions

The first part of the survey describes boaters in terms of length of experience, frequency of lake use, distance traveled to the lake, duration of visit, boat type and size, and boating activities. The majority of the mail-back survey respondents have visited the lake before 2009 and the majority held more than 16 years of boating experience. Boaters with the longest histories will be the most accustomed to the lower-density recreation opportunities that the lake used to provide (historically) and are, generally, more sensitive to social impacts. It follows that these veteran boaters are more likely to oppose new developments, especially in areas that are presently undisturbed. Most of the boaters interviewed lived in Missouri and traveled less than 30 miles to the lake. Both groups visited most frequently on weekends; the largest portion of ramp users (31%) and mail-back survey respondents (41%) visited the lake more than 50 weekend days in the previous year which indicates high local and loyal use. It follows that boater conflicts will be most likely to occur during times of peak usage. The majority, forty-seven percent of ramp users and fifty-one percent of mail-back survey respondents, stayed four to six hours during each visit. Runabout boats were the most popular watercraft among ramp users (39%) and mail-back survey respondents (40%). Mail-back survey respondents used larger boats with more horsepower; 23 feet and 217 horsepower on average; ramp user's boats averaged 19 feet and 171 horsepower. There only small differences in the way ramp users and mail-back survey respondents spent their time on the lake; cruising, fishing, and skiing were the most popular activities with each group.

4.1.2 Boaters' Perceptions and Preferences

The second portion of the surveys evaluated boaters' perceptions and preferences with categorical and open-ended questions. Boaters were asked to identify locations that they favored, avoided, and felt unsafe at, and explain why. Several questions addressed boaters' perceptions of conflict with other boaters and the number of facilities provided at the lake. An additional section inquired about changes boaters have noticed. Space for additional comments was also provided. Responses to open-ended questions were tabulated in social, physical resource, facility, or managerial categories.

The locations boaters favored on the lake varied, but the conditions they sought were similar. The largest portion of each group indicated that convenience followed by solitude were the attributes of their favorite places. This finding is consistent with results from other boater capacity studies. As with favored locations, the places boaters avoided were varied, but the conditions they avoided were not. The largest portion of each boater group cited overcrowding, traffic, and rough water/ hazards as attributes of locations they avoided. Similarly, crowding

followed by water conditions or obstructions were features that made boaters feel unsafe. Mail-back survey respondents were more sensitive to boat traffic and unsafe boating behavior than were ramp users. Although boaters reported avoiding some areas of the lake due to safety concerns, the majority of each group (84% of ramp users and 76% of mail-back survey respondents) reported feeling "extremely safe" on the lake.

Seventy-nine percent of ramp users and 41% of mail-back survey respondents felt that the lake was "not crowded." Many respondents indicated that increases in ranger patrols, new regulations, and facilities improvements enhanced their experience in a positive way. In contrast, increased boater traffic, personal watercraft usage, undesirable policy changes, facility decline, fluctuating water levels or poor water quality negatively diminished their experience. Many visitors desired restrictions on personal watercrafts and rule enforcement. Mail-back survey respondents desired additional campgrounds or parking facilities. Although there were some requests for additional facilities, more than 68% of each boater group felt that the current number of parking areas, boat ramps, and marinas was "about right."

4.2 Key Findings for Management

The primary finding of this boating conflict classification study is that Table Rock Lake should be managed for priority management compartments and zones which contain Class I or Class II management compartment classifications indicating higher conflict/density. These compartments are priority concerns for safety as validated by the higher accident/incident rates found in Class I and Class II management compartments as opposed to those represented by other classes.

When viewing the management compartment classification maps for the 20 to 100% projected increases in average number of boats, it appears that, at a 60% increase in boats above the number of boats counted in this study, there is a threshold of crossing nearly half of Table Rock Lake's management compartments as being a Class I designation for density/conflict. Therefore, management should strive to conserve use levels to prevent these levels from exceeding this threshold. Without this type of management strategy, opportunities for other classes of experience on the lake will be eliminated and those boaters looking to fish, swim, or relax quietly will likely be displaced elsewhere to seek out their recreational experiences.

Problematic areas identified as areas to avoid and that are unsafe by boaters in these Class I compartments include Kimberling City, the dam area, the main channel, the state park, and Aunt's Creek among others. To mitigate the negative attributes cited by boaters for why they avoid those locations, management will need to consider increasing law enforcement strategies to curb unsafe boating behavior, illegal behaviors associated with alcohol consumption, enforce or post speed limits, and remove debris hazards from the water.

Class II management compartments were, generally, highly variable in their density and conflict levels. These management compartments such as Joe Bald, Lower White, Shell Knob-Campbell Point, Central White, and Holiday Island should be examined more closely to determine the cause of conflicts. For example, although Holiday Island had very low density, conflict levels were high. The reason for the high conflicts in this management compartment is related to the developed, resort setting of this small wooded island where activities such as smaller craft rentals are commonly conflicting with other boat traffic.

Visitors also cited crowding and boat traffic as primary reasons for avoiding the unsafe locations mentioned above. Social condition strategies to reduce crowding/density may include reducing parking, slips, leases, or concessions or other development near the above locations on the lake. Other strategies to mitigate the above social impacts that could be considered include dispersion strategies or temporary closures of areas to rehabilitate the resource and redirect traffic to other locations.

Despite having some select areas where boaters are raising safety and crowding concerns, the majority of boaters perceived that the ramps and lake were moderately to extremely safe. Therefore, the overall condition of law enforcement and regulations appear to be effective in providing perceptions of Table Rock Lake as a safe lake to boat. In fact, many of the respondents listed the increased patrols and law enforcement as being very beneficial to their experience.

Mail-back survey respondents appear to be more sensitive than ramp users to social impacts as indicated by their relatively higher ratings of crowding and concerns for safety. In fact, the majority of mail-back survey respondents responded that the lake was at least moderately crowded to extremely crowded. Perhaps these boaters have more of a sense of ownership or investment in the resource both physically and financially causing them to perceive impacts more than ramp users.

Overall, crowding perceptions were lower than expected by the researchers of this study. The moderate crowding scores among ramp users are likely related to the fact that most ramp boaters on Table Rock Lake are in groups of three to four people already and come to TRL for the social setting and experience of watching other boaters, many of whom they might already know since local, regular boaters comprised the majority of the ramp user sample.

The comments to open-ended questions made by ramp users included multiple references to more “bigger boats” suggesting some negative concerns for the larger pontoon boats on TRL. Boats on Table Rock Lake did average to be longer (19.4 feet for ramp and 23.4 for mail-back survey respondents). Therefore, with a further increase in larger boats on the lake an increase in these negative concerns may heighten among those with smaller boats. Many negative references were made about the unsafe behavior of jet skiers (PWCs) as reported in their additional comments. Many boaters also noted negative changes in the resource such as increased traffic and dirtier water. Positive changes listed in the comments included better fishing, docks, cleaner water, less garbage and increased law enforcement. Thus, management appears to have been effective at cleaning up the area and providing an increased presence.

With cruising being the primary activity of both ramp and mail-back survey respondents, it heightens the potential for future conflict and safety concerns since an increasing number of moving boats are always more intrusive and of more risk to swimmers, skiers, and fishermen. Furthermore, with mail-back survey respondents listing their secondary activity as relaxing, this group may be more sensitive to louder boats and the sheer number of boats as an interruption of this activity.

The high frequency of swimming on the lake among both ramp users and mail-back survey respondents suggests that water quality is high on the list of concerns but many perceptions were that water quality has been improving well and appears to be a lot cleaner than it once was. However, many respondents also mentioned a decrease in water quality so there appears to be a split decision on the improvement of water quality.

Some locations were much more important to boaters such as Cape Fair, Cow Creek, Aunt's Creek, and Long Creek. Ramp users and mail-back survey respondents, as a majority, cited close, familiar, solitude, relaxing, good fishing, good facilities, and calm water and scenery, as the primary reasons that they visited their favorite location. To manage for these qualities, it appears that these favorite locations should contain low speed or no wake zones to allow for calmer water, better fishing, and quieter solitude for relaxing.

A number of comments were made about the need to improve facilities; however, many boaters also listed negative concerns about increasing developments on the shoreline. The survey data indicated that some additional boat ramps, campgrounds, and parking areas should be considered but it does not support other substantial developments, such as marinas.

The results of inferential statistics in this study indicate that perceptions of crowding are correlated with the need for more facilities such as boat ramps, parking and marinas. This finding indicates that the development of more adequate facilities could decrease perceptions of crowding among TRL boaters. This may be particularly true for those boating on cabin cruisers who preferred additional marinas. Fishermen appear to be significantly opposed to additional developments such as building more boat ramps. Crowding perceptions correlated with perceptions of safety indicating that increasing use could increase perceptions of danger among boaters conducting their recreational activities on TRL.

Based on the above key findings, the researchers of this study recommend the following to USACE management:

1. Preventing a substantial (i.e., 60%) increase in existing use levels;
2. Preserving opportunities to escape existing heavy boat traffic and high wakes; and
3. Reducing conflicts through increased and improved boater education, on-water law enforcement and patrol, and by limiting density levels through dispersion or allocation strategies.

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