Boating Capacity Study
Lake Granbury, Texas

FINAL REPORT

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Decision Support for Lake Managers

Executive Summary

Description and Purpose of the Study

The Brazos River Authority (BRA) contracted Park Studies, Inc. (PSI) to conduct a boating capacity study on Lake Granbury (LG) over a one-year period. Actual data collection occurred during a 12-week period from May 28, 2005 to August 15, 2005. The primary purpose of the study was to provide BRA management with a baseline by which to make future development decisions for the lake. The study focused on boating density, crowding, and public safety related to understanding what issues are most important to the boaters. This information was deemed useful to resource managers in promoting the safe and healthy use of the lake while providing high quality recreational experiences.

Survey Study Methods

Three groups of LG users were targeted for soliciting survey responses that included: 1) on-site exit interviews with those removing their boats from public boat ramps on LG; 2) a mail-back survey of marina slip renters; and 3) private dock owners. In addition, actual physical boat counts were systematically conducted during the course of the study in order to document the amount and type of boating use by location on the lake.

The Lake Granbury Boater Results

A total of 123 ramp user surveys were administered at public boat ramps. 800 surveys were mailed to a sample of marina slip renters and private dock owners. There were 649 valid surveys and 43% (281) were returned. The total sample size was 404 boaters.

- The typical boat ramp user at LG has been boating on the lake for an average of 9.6 years while marina slip renters and private dock owners have been boating for an average of 11.0 years.
- The average number of weekend days boating for ramp users was 16.6 days while marina slip renters and private dock owners boated 19.5 days.
- The average number of weekdays boating for ramp users was 15.6 days while marina slip renters and private dock owners boated 17.5 days.
- While LG boaters come from more than 30 cities around the area, the largest groups were from Granbury (33%).

Activities on Lake Granbury

- The typical boat ramp user at LG has a boat that is 18 (17.69) feet long for an average while marina slip renters and private dock owners have boats averaging 19 (19.47) feet long.
- The average horsepower for ramp users was 180 and for marina slip renters and private dock owners it was 155.
- About 39% of all LG boaters indicated they used a runabout boat, speedboat, or a ski boat, while 30% indicated they used a fishing/bass boat, and 17% used a personal watercraft.

- Other boats used less frequently on LG included pontoon boats, high performance boats, and house boats. No boater surveyed reported using a cabin cruiser, flat bottom boat, Jon boat, V Hull, Sail boat or sail board.
- The majority of LG boaters appear to spend most of their time on the lake water-skiing (26.7%), cruising (21.8%), fishing (21.6%), and on a personal watercraft (10.1%) or swimming (9.9%).

What Boaters think about Lake Granbury?

Boaters were asked if they had a favorite location on LG, whether there were any locations on the lake that they deliberately avoided, and whether there were any locations on the lake that they thought were unsafe. In addition, the boaters were asked to identify the location and explain why they considered it his/her favorite, why he/she avoided any locations, and why he/she thought a location was unsafe.

- The favorite locations included the following: by the dam, the area between Highway 377A and 377B, Sandy Beach, Indian Harbor, and Rough Creek. Boaters tended to avoid locations such as areas north of Highway 51, the northeast end of the lake, and areas past Highway 377B.
- Most boaters indicated they enjoyed the calm waters of the lake and protection from the wind provided by the bluffs, others enjoyed the openness of the lake and the shallow waters, which allowed them to swim or play in the water. Others appreciated the fact that they knew they could always catch fish on LG.
- Almost two-thirds of the boaters did not like the stumps that are in the lake. This was cited as the major reason why they avoided certain locations on the lake.

Safety and Conflicts on Lake Granbury

- A light majority of ramp users (50.8%) reported feeling extremely safe on the water, with 33.1% feeling moderately safe, 11.3% feeling somewhat safe, and 3.2% feeling not at all safe.
- Twenty-seven percent of marina slip renters and private dock owners indicated a feeling extremely safe while on the water, with 45.6% feeling moderately safe, and 12.1% reporting they felt somewhat safe. Only 1.8% reported they did not feel safe at all while on LG waters.
- In terms of feeling crowded on the water at LG, 39.5% indicated they did not feel crowded, while 18.5% of ramp users reported feeling somewhat crowded and surprisingly, 29.8% reported moderately crowded. However, 11.3% of ramp users reported being extremely crowded.
- Marina slip renters and private dock owners showed greater sensitivities to crowding on the water. Only 26.0% indicated that they felt not at all crowded, while 39.5% of ramp users felt it was not at all crowded. Thirty-two percent of marina slip renters and private dock owners felt somewhat crowded, with 23.8% moderately crowded, and 10.7% extremely crowded
- When asked whether there were an adequate number of marinas, a majority of ramp users (60.5%) felt the number was about right, yet 37.1% felt the need for more. Surprisingly, no responses indicated there were too many.

- For marina slip renters and private dock owners, 39.5% indicated that there were an adequate number of marinas, 42.0% indicated the need for more, and 2.8% felt there were too many.

Changes on Lake Granbury – Likes, Dislikes, and Desires

- Almost two-thirds (65%) of the boaters had noticed changes on the lake on LG over the past five years and 35% had not noticed any changes on the lake. Of those, two-thirds, 43% of LG boaters had noticed negative changes; 4% LG boaters had noticed both negative and positive change while 18% of LG boaters had noticed positive changes.
- Notable positive changes noticed included cleaning up of beaches, more ramps, a marina and docks added to the lake, removal of stumps, working on removing the golden algae, and more law enforcement agencies patrolling the lake.
- Negative changes noticed included: more golden algae, a fluctuating water level, crowding on the lake, high boat traffic, and more development along the lake. Some LG boaters felt that there was a lack of Lake Ranger patrols, especially during the holidays.

GIS and Boating Capacity Methods

Data collected during the summer of 2005 at Lake Granbury were used to develop classification maps. Conflict data were collected from mailed surveys (marina slip renters and private dock owners) and from exit interviews on the boat ramps. Conflict maps were developed that show the location of areas that boaters considered their favorite, unsafe, or avoided. 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. Favorite responses were not considered conflict areas. Percentages for each management compartment were found by finding the percent of conflicted responses to the total number of responses for each management compartment.

Areas with a conflict percentage of <6% were considered as low conflict, 6%-12% were considered as moderate conflict and >12% were considered high conflict (ES Table 1). Boat density was computed from scheduled boat counts (ES Table 2). The lake was divided into four zones. Lake Rangers and data collectors made four counts in each zone

– two on weekdays and two on weekend days for a total of 16 boat counts.

ES Table 1: Management Compartment Classification Criteria Matrix			
Use Level	**Incidence of Conflict**		
	High	Moderate	Low
Very High	I	I	III
High	I	I	II / III
Moderate	I	II	II
Low	II	II	IV
Very Low	II	II	IV

ES Table 2: Boating 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

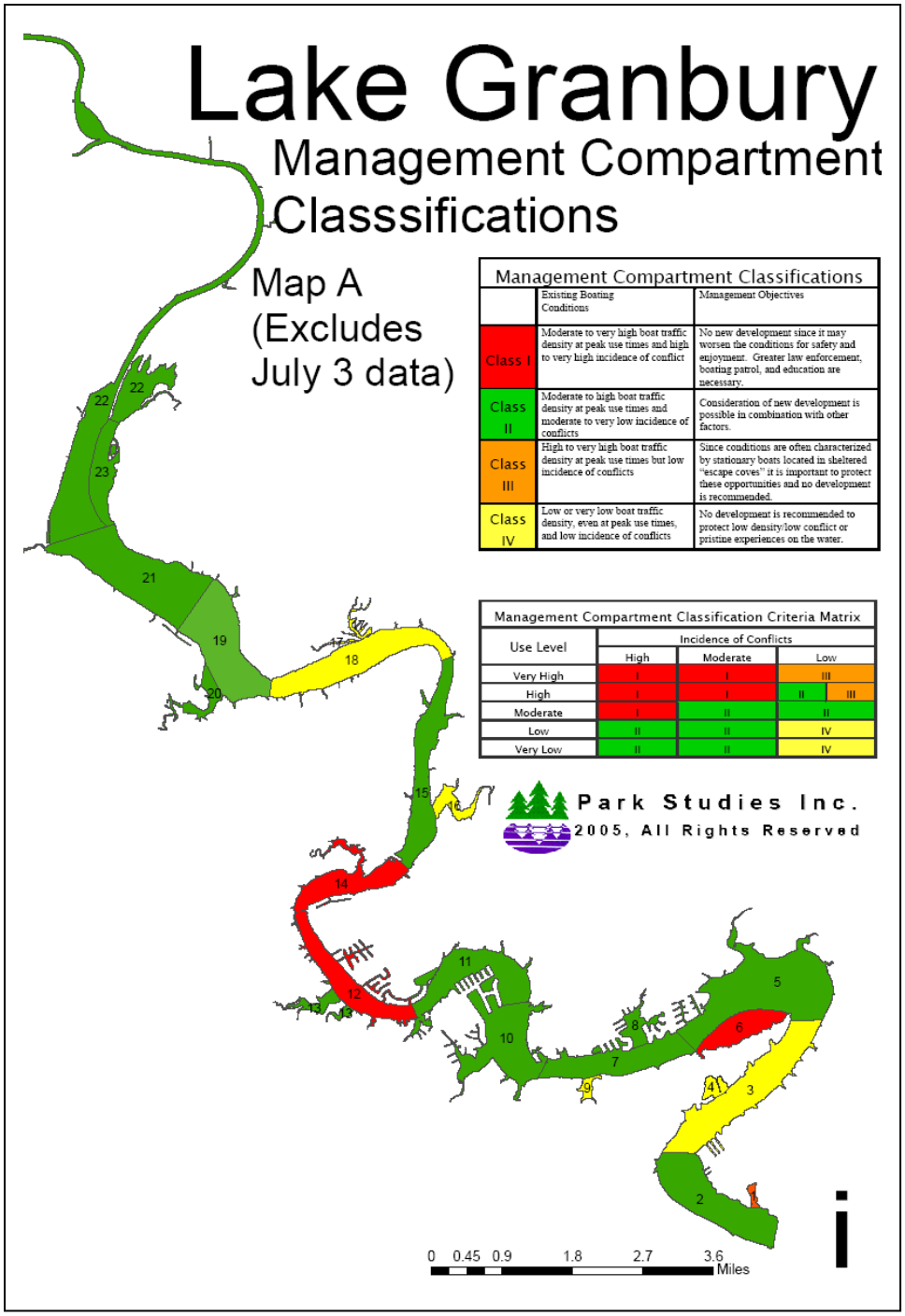
Management compartment density was found in two ways. Map A uses only data from scheduled counts (excludes July 3) with a 66.7% weight for weekends and 33.3% for weekdays (ES Table 3). Map B includes data from July 3. Each weekend day contributed 25% for a weighted influence of 50%. Each weekday contributed 12.5% for a weighted influence of 25%. July 3 counted for 25% and only contributed to Map B.

ES Table 3: Time Period Influence on Maps A & B		
Time Period	**Weighted Influence**	
	Map A	Map B
Weekdays (2 days)	33.3%	25% (12.5%x2days)
Weekends (2 days)	66.7%	50% (25%x2days)
July 3	0	25%

After the number of boats per management compartment was found, they were divided into the acres to find acres per boat. Density levels were computed from the density chart.

To find the final classification for each management compartment, density levels and conflict levels were examined in combination. After classifications were found, maps were developed for each lake, for each scenario (Maps A and B), including maps based on projected increases in density (20%, 40%, 60%, 80%, and 100%) for the lake. ES Table 4 shows the recommended criteria for compartment classification. Map A is shown here as the recommended map for LG while Map B is provided in Appendix B. Although it was mentioned by respondents that 2005 may have been a low use year for boating in the region, no hard evidence was found to support that assumption; therefore Map A remained the recommended map.

ES Table 4: 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.



Management Recommendations

These recommendations are based on cooperating partner workshops, public workshops, e-mail and written correspondence, and consultant experience.

- Resolution necessary to address existing conflict of boat traffic, economic development, and environmental concerns
- Establish no-wake zones, special use zones, and restricted areas as appropriate
- Continue to install and number lighted centerline buoy markers
- Obstacle identification/selective reduction for public safety
- Develop standards for docks and retaining walls in conjunction with county and city
- City and county explore shoreline buffers
- Seek improvement opportunities for BRA public use areas

Summary Recommendations

This study recommends no further development in management compartments I, III, and IV that would result in additional boating density and potential conflicts in those areas.

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1. Introduction

The Problem

The rapidly increasing use experienced at many lakes in recent years has a significant effect on the quality of water-based recreation at those locations. 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. It has also depreciated the quality and the availability of certain activities such as water skiing and fishing which; in order to be more enjoyable, require few wakes and the space to participate in them. The public launch ramps at Lake Granbury have seen more visitations and are often congested during high-use periods such as weekends and holidays. Some pressure for ramp and marina expansion has been placed upon the managers at the lake.

While management has received requests for additional development, they also suspect escalating social problems on the lake, including increasing conflicts and threats to safety and enjoyment. Balancing these requests, while continuing to provide safe and enjoyable recreation opportunities, requires providing the opportunity for a full range of experiences. These vary from the low-density, "get-away" type to the higher-density, more social experiences that are also popular.

Objectives

The primary objective for the Lake Granbury study was to:

> Provide BRA management with a baseline by which to make future development decisions for the lake.

Secondary objectives were to:

1. Describe the recreational patterns of three boater groups: public launch ramp users, marina slip renters, and private dock 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.

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 for.

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 and visitors alike. Once this is accomplished, appropriate strategies can be developed to address objectives for short and long-term planning.

Boating capacity is defined by density and conflict parameters explained later in this report under the discussion of management compartments.

In 1982, Washburne proposed that recreational carrying capacity be conceptualized as a set of conditions (physical-biological, social, and managerial) to be managed for, 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) because it most directly incorporates a low-cost managerial approach with emphasis on inventory 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 Corps. More recently the methodologies have been tested at Table Rock, Beaver, and Norfolk Lakes (Titre and Vogel 1993, 1995, 1996). 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.

The Need for Management Information and Evaluation Procedures

Brazos River Authority (BRA) managers are charged with the complex task of providing safe and enjoyable recreation opportunities while protecting the natural

resources where those recreational activities occur. This report was an opportunity to work with several agencies on a host of issues. These efforts should continue as cooperating partners address common challenges.

Considerable information is provided about the conditions on Lake Granbury; 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.

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 Lake Granbury 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.

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 are included:

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

Responses to each survey 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 was to provide BRA management with a baseline by which to make future development decisions for the lake. This was done by obtaining data from boaters on their use of the lake, their perceptions and preferences regarding the natural resource, other visitors, facilities, and management policies.

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).

A Five-Step Process© to Address Boating Capacity

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 to evaluate requests and address problems.

However, this process begins with guiding concepts developed by Park Studies:

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

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 waters 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.

Process

The five-step process in Figure 1 is a collaborative learning model allowing for full participation of all stakeholders at various stages. Step 1: A meeting is convened to elaborate the issues among cooperating partners 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 cooperating partners 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 cooperating partners 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.

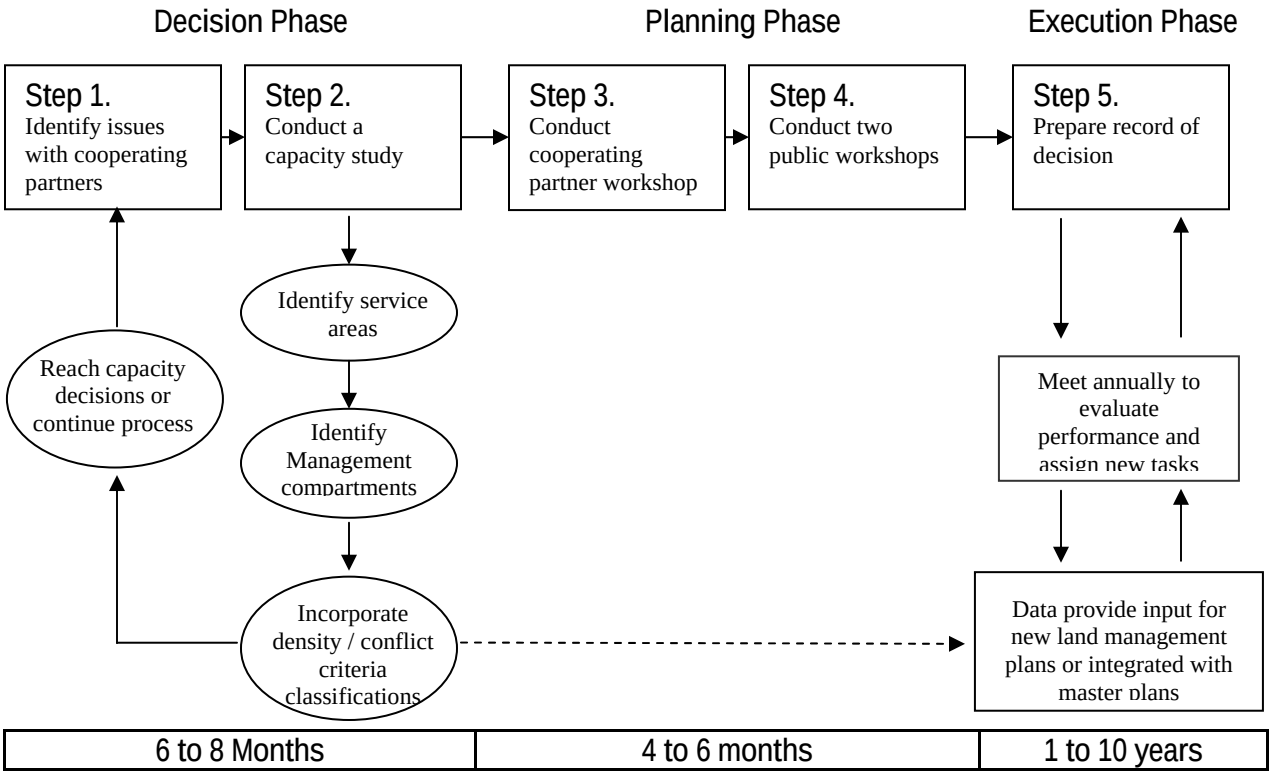


Figure 1. Collaborative Learning Model for Capacity Decisions

Partnerships

Park Studies recognizes three types of stakeholders. First, there are cooperating partners who have some statutory responsibility for managing the resource. Second, there are organized interest group stakeholders who care about some piece of the pie such as marinas, private docks, 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. We have learned that 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 non-government organizations (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 cooperating partners to be at the same table when issues are discussed (Step1) prior to initiating a study (Step 2).

Collaboration

Once a list of proposed actions to address study findings is agreed upon, the collaborative learning process can go before interest groups and cooperating partners (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 the community 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 public workshop setting provides a non-confrontational atmosphere for discussing decisions before they are made. Cooperating partners 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 cooperating partners 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.

Criteria

During the past twenty 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.

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

We have 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. 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 TVA and Carters Lake in Georgia in 2002 managed by the Corps. The criteria combine boating density and conflict data according to four classifications. 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.

ROS 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

Figure 2. Water-based Recreation Opportunity Spectrum

BOAT DENSITY (Acres/Boat)	USE LEVEL	INCIDENCE OF CONFLICTS		
		HIGH	MODERATE	LOW
		(> 12.0%)	(12.0 – 6.0%)	(< 6.0%)
< 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

Figure 3. Management Compartment Classification Criteria Matrix

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. Methods

Introduction

BRA 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. This section of the report discusses the methods used to collect data for the 2005 boater study on Lake Granbury. First, the inventory and sampling methods are presented that were used for the boater survey component of the study. This is followed by description of the on-the-water boat count procedures. This section is concluded with a discussion of the survey instrument. These procedures have been developed during similar studies at Corps and TVA lakes.

The approach to information collection and analysis that was followed in this and preceding carrying capacity studies at Corps lakes stresses detailed inventory of the resource and its use. Data collection for this study included exit interviews with boaters using public launch ramps, mail-back surveys of boaters renting marina slips, private dock owners, and counts of boats on the water. The exit interviews and mail surveys focused on gathering information on use patterns, and on the perceptions and preferences of boaters using Granbury Lake. The boat counts provide additional information about boat distribution. Numerous texts elaborate survey research procedures; however, we prefer the basic reference by Fowler (1993).

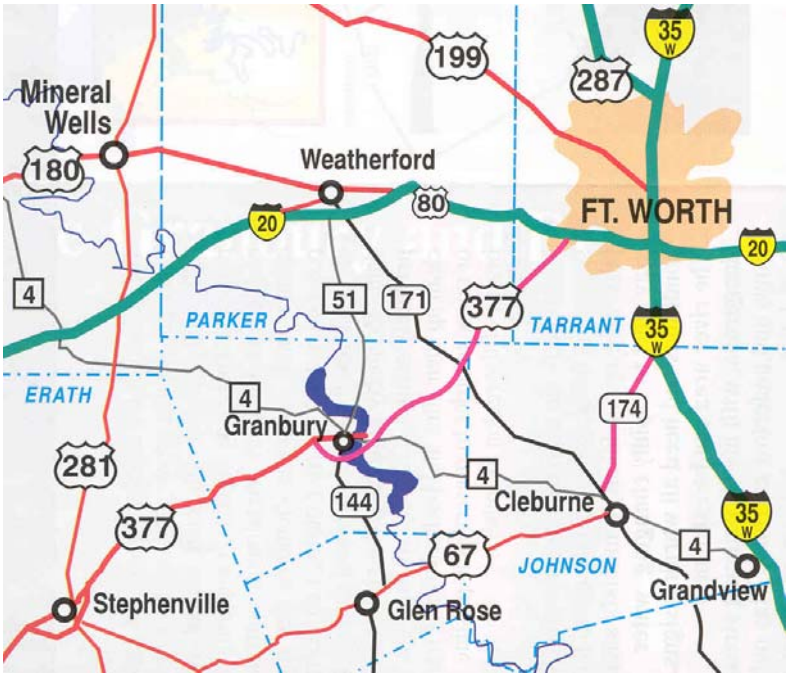
Reconnaissance and inventory of the study area, and preliminary planning preceded the data collection. Study methodologies are provided below to explain the concepts and rationale behind implementation of this lake study.

This study is a part of a national research program directed by Park Studies. Included in this study are boater exit surveys conducted at boat ramps from May 28, through August 15, 2005. 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.

Study Area

Lake Granbury is located in Hood County, Texas near the town of Granbury. It is a narrow lake located in the middle of town and is about 35 miles long. It has a stable water level with good fishing. It has some 6000 private boat slips.

The lakes' many miles of shoreline provide easy access from numerous coves and cut-through canals. This provides visitors with a variety of recreational opportunities including fishing, boating, water-skiing, and swimming.



Location of Lake Granbury

Sample Populations

The population for the study consisted of boaters using Lake Granbury. For the purpose of sampling, the boaters were separated into three survey groups as determined by their mode of access to the lake; public launch ramp users and marina slip renters/dock owners.

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 contained in project records, maps and field checks conducted from the land and water.

Sampling Methods

Ramp Users. A total of 12 launch ramps were identified during the survey planning inventory. High-use ramps were: Rough Creek Park, De Cordova Bend Park, City Beach, Hunter Park, and Rio Brazos. Low-use ramps were: Pecan Plantation, De Cordova, Indian Harbor, Mallard Point, Sky Harbor, Thorp Springs, and Oak Trail Shores.

To ensure representation of the entire range of boaters using the public ramps, a stratified random sampling procedure, with boat ramp interview sites split into "high use" and "low use" stratum, was used in scheduling the exit interview periods. This stratification allows for the possibility that boaters using the two larger public ramps would differ from those using the smaller ramps. The larger "high use" ramps serve more

boaters than the smaller ramps and the smaller "low use" ramps are only suitable for launching smaller boats. The ramps placed in the "high use" stratum were mentioned above. The seven ramps placed in the "low use" stratum are Pecan Plantation, De Cordova, Indian Harbor, Mallard Point, Sky Harbor, Thorp Spring, and Oak Trail Shores.

Brazos River Authority Lake Ranger

Marina Boaters. There are five marinas on Lake Granbury. The operators of the marina provided mailing lists with the names and addresses of current slip renters for use during the mail survey.

Private Dock Owners. Since there are approximately 6000 slips on Lake Granbury it was necessary to systematically select every 15th address to obtain a sample of 400.

The two different methods used to contact the members of the three boater groups who together comprise the study population required different sampling methods. The public ramp users were contacted during randomly selected exit interview periods.

Exit Interview Schedule. To increase the probability of obtaining an adequate sample of ramp users, exit interview periods were scheduled on all available weekend days, and an equal number of weekdays. The weekdays on which interviews would be conducted at ramps were selected by numbering the weekdays available during the data collection period of May 28 to August 15. A random number table was then used to select the weekdays on which interview periods would be scheduled. The selected weekend and weekday interview days were then randomly divided into two groups, which would have "morning" interview periods (9:00 a.m. to 11:00 a.m.) and "afternoon" interview periods (4:00 p.m. to 7:00 p.m.). Finally, individual ramps were randomly assigned to each interview period with half the periods allocated to "high" use ramps and half allocated to "low use" ramps.

Sampling Limitations

1. No public boat ramp could be sampled more than five times during the twelve week period.
2. All public boat ramps must have at least one on-site interview conducted at the site.

3. All weekdays and weekend days were treated equally for sampling purposes.
4. On-site interviews were conducted for all weekdays and weekend days.

Boater Survey

The boater survey portion of the study was conducted from May 28, to August 15, 2005. The survey was designed to allow information to be gathered 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, and those who own a private dock.

Boaters using public launch ramps were interviewed after they had removed their boat from the water at public launch ramps. Marina slip renters and dock owners were contacted through mail-back survey questionnaires. Exit interviews and mail surveys were conducted by PSI employees who underwent interviewer training prior to the start of data collection. Sampling and data collection was coordinated from PSI.

Study Methods

Three sources of LG users were targeted for soliciting survey responses that included: 1) on-site exit interviews with those removing their boats from public boat ramps on LG; 2) a random mail survey of slip owners drawn from the 5 LG marinas; and 3) a random mail survey drawn from 6000 boat slips. In order to provide more accurate boating estimates on LG, actual physical boat counts were systematically conducted during the course of the study. The ramp survey was conducted during a 12-week period from Saturday May 28, 2005 to Sunday August 15, 2005.

Based on key LG cooperating partner recommendations, five of the 12 public boat ramps were labeled as high-use boat ramp areas, and seven were labeled as low-use boat ramp areas. The sampling strategy involved drawing 75 percent of the on-site exit interviews from the high-use boat ramp areas, and 25 percent from the low-use boat ramp areas. In addition, 40 percent of the on-site exit interviews were scheduled for the morning and 60 percent were scheduled for the evening. Due to lack of participation at the low use ramps, no people there, it was decided to concentrate sampling at other times and places to take advantage of greater numbers of boaters.

Overall, there were 21 weekdays and all 25 weekend days scheduled for on-site boat ramp sampling over the 12-week period in addition to July 3. Two weekdays per week were sampled. This is consistent with previous studies (Titre et. al, 1995, 1996). A random numbers table was used to determine which boat ramps and weekdays to schedule for the on-site exit interviews. A coin toss was initially used to determine whether the first boat ramp selected was going to be sampled during the morning hours (heads) or during the evening hours (tails). Afterwards, the time of day alternated for each boat ramp selected. This resulted in the five high-use boat ramp areas being selected for on-site exit interviews between one to five times over the duration of the study; and zero to two times for the seven low-use boat ramp areas (Tables 1 and 2). These sampling percentages were used for both weekdays and weekend days.

Table 1. Allocation of Sampling Days for High-Use and Low-Use Boat Ramp Areas on LG during Weekdays			
High-Use Boat Ramp Areas	**Number of Sampling Days**	**Low-Use Boat Ramp Areas**	**Number of Sampling Days**
Rough Greek Park	4	Pecan Plantation	0
De Cordova Bend Park	2	De Cordova	0
City Beach	5	Indian Harbor	2
Rio Brazos	1	Mallard Point	2
Hunter Park	4	Sky Harbor	1
		Thorp Springs	0
		Oak Trail Shores	0

Table 2. Allocation of Sampling Days for High-Use and Low-Use Boat Ramp Areas on LG during Weekend Days			
High-Use Boat Ramp Areas	**Number of Sampling Days**	**Low-Use Boat Ramp Areas**	**Number of Sampling Days**
Rough Greek Park	3	Pecan Plantation	1
De Cordova Bend Park	2	De Cordova	1
City Beach	5	Indian Harbor	2
Rio Brazos	4	Mallard Point	0
Hunter Park	5	Sky Harbor	0
		Thorp Springs	1
		Oak Trail Shores	1

Boat Count Methods

Boat counts were collected in each of the four lake zones that were identified by key LG cooperating partners. The boat counts were scheduled during peak afternoon periods from 4:00-6:00 p.m. for weekdays and 4:30- 6:30 p.m. for weekend days. Saturday and Sunday are considered weekend days. These time periods are considered a peak period when most boats are on the water. This sampling scheme resulted in a total of 16 boat count days, with each of the lake zones being counted twice during the weekdays and twice during the weekend days (Table 3). This is standard for obtaining boat count data (Titre & Vogel 1993). The boat counts were administered by a boat operator and a recorder, who recorded the type of vessels operating in each zone conducted during a two-hour time frame. The boat counts were conducted on days when the weather conditions were favorable. As such, boat counts represent a typical day and not a random sample day. If weather conditions are poor, boat counts can be rescheduled to a day when "normal" weather is available[1].

[1] The exception here includes data gathered on July 3 based on evidence that 2005 was a low use season. However, for Lake Granbury, no supporting data were available to test this hypothesis.

Table 3. The Schedule Boat Count Sessions for the Four Zones on LG			
Zone	**Weekdays**	**Zone**	**Weekend Days**
One	June 7	One	June 5
One	July 5	One	July 17
Two	June 17	Two	June 25
Two	August 2	Two	July 24
Three	June 27	Three	June 26
Three	August 8	Three	July 31
Four	June 13	Four	June 18
Four	July 22	Four	July 23

On-Site Survey Methods

The questionnaires for both the on-site boat ramp exit interviews and the mail-back surveys to marina slip renters and private dock owners contained the same set of questions. The questionnaire consisted of typical demographic items, experience use history items, safety-related items, and items related to the place attachment concept (Appendix A). For the on-site exit interviews, a trained staff member approached every group who was removing their boat from the lake. The staff member introduced himself/herself, explained the purpose of the study, and solicited one person to participate in a face-to-face interview. The interview was administered individually and not to the group. When finished, the interviewer thanked the boater for his/her time and cooperation. Refusals were recorded. They represented less than 5% of all face-to-face interviews. Refusals were due to time or bad weather. In contrast, most boaters appreciated the opportunity to talk about their experience.

Although every exiting boater group was desired, if two groups were exiting at the same time, a coin was tossed to determine which group to approach. For three or more groups, it was decided to select the n^{th} group based on the number of groups exiting. This was done so that there was no potential bias of selecting who was interviewed for the survey questions.

Mail-back Survey Methods

Mailed surveys were sent to a sample of marina slip and private dock owners using an approach pioneered by Dillman (1978). Questionnaires were mailed to marina slip renters and private dock owners during mid-summer allowing them to respond to the survey having had recent experience with boating conditions on the lake. This entailed mailing an initial packet of material that consisted of a cover letter explaining the purpose of the study, the questionnaire, and a self-addressed stamped envelope. After two weeks, a reminder postcard was sent to those sampled in order to solicit greater response; and after two more weeks an entire package was again sent to those who had yet to respond.

The Survey Instrument

One area of emphasis during the carrying capacity 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 about their perceptions of "quality" conditions on 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 lakes.

Information is obtained about visitor and visit characteristics, how the study area compares to other similar areas in the region, visitors perceptions and preferences for use levels and perceptions of conflicts, and changes occurring.

Boater Survey Questions

I. Visit Characteristics
- Length of experience
- Distance traveled
- 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

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

Data Analysis

All survey data were entered into Statistical Program for the Social Sciences (SPSS ™), a statistical software package for analysis. The boat count data from the maps were stored and graphically displayed using Arc Info9™ software. Statistical analysis techniques were used to summarize all boater responses.

Management Compartments Defined

Management compartments are based on an understanding of resource, management, and social conditions. During the first cooperating partner workshop, the PSI facilitator directed a session explaining the need to segment the map of the lake into logical compartments based on the three conditions mentioned.

Resource conditions include:

a. Bends in the lake
b. Natural coves
c. Physical structures such a bridges
d. Submerged tree stumps
e. Differences in water depth
f. Wide and narrow expanses of water
g. Prevailing winds or other weather conditions

Management conditions address boater safety and environmental sustainability to include:

a. The abundance and scarcity of unique resources that may need protection
b. Knowledge of supply and demand factors
c. Hazardous areas
d. Concentrations of development such as restaurants, marinas, private docks
e. Distance from Lake Ranger patrol functions or sub-stations
f. Other management influences such as the Coast Guard Auxiliary and Game and Fish personnel available to assist with education and enforcement
g. The ability to apply "light-handed" options such as education
h. The ability to apply "heavy-handed" options through law enforcement

Social conditions address the boating opportunity provided to include:

a. The amount and type watercraft
b. Traditional use patterns
c. Emerging trends
d. Cultural significance of certain locations
e. Regional opportunities that are the same or different

The collective understanding of the above conditions allowed the cooperating partners to draw management compartments to later facilitate the formation of management strategies designed to maintain the desired condition for specific recreational experiences in a given area.

Classification of Management Compartments

Classifying the lake into categories for the purpose of directing future desired conditions is accomplished by combining two sources of information. These sources are boat density and "conflict" data (areas of the lake that are considered unsafe or avoided).

Boat Traffic Density. Boat density data are gathered by recording all boats on the water during peak use periods on weekdays and on weekend days. The lake is divided into boat count zones that permit the recording on-the-water boats within a two-hour time period. Recorders also note the type of craft according to a predetermined check sheet and a map.

Park Studies developed a boat traffic density table based on 30 boating capacity studies as a guideline to compute acres per boat. A condition where acres per boat are less than 10 is considered a threat to safety and enjoyment (Table 4).

Table 4: 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

Incidence of Conflict and Boater Density

This information is gathered by showing boaters a map of the lake and asking them to identify avoided and unsafe locations. Three categories of conflict were determined based on percentages: high > 12%, moderate 6 – 12%, and low < 6%.

Boater density is the amount of surface water available for each boat. This information is derived from the boat count data. Boater density data are the best means of comparing use levels between times of high and low usage as well as over several years. In addition, density strongly correlates with boater conflicts. As boater density increases, so does the percent of conflicted areas within a management compartment. Boater conflict is defined as the number of avoided and unsafe locations within a management compartment divided by the total number of avoided and unsafe locations on the lake. An area with fewer than 6% of the total conflicts for a body of water is "low" on the conflict scale while an area with more than 12% of conflicts for a body of water is "high" on the conflict scale. 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 5: Conflict and Density Criteria			
Conflict Scale (# of avoided and unsafe locations within a compartment/total avoided and unsafe locations on lake)		**Density Criteria (Surface water/boat)**	**Use Level Category**
<6.0% 6.0-12.0% >12.0%	Low Moderate High	>25 acres 20-25 acres 15-20 acres 10-15 acres <10 acres	Very Low Low Moderate High Very High

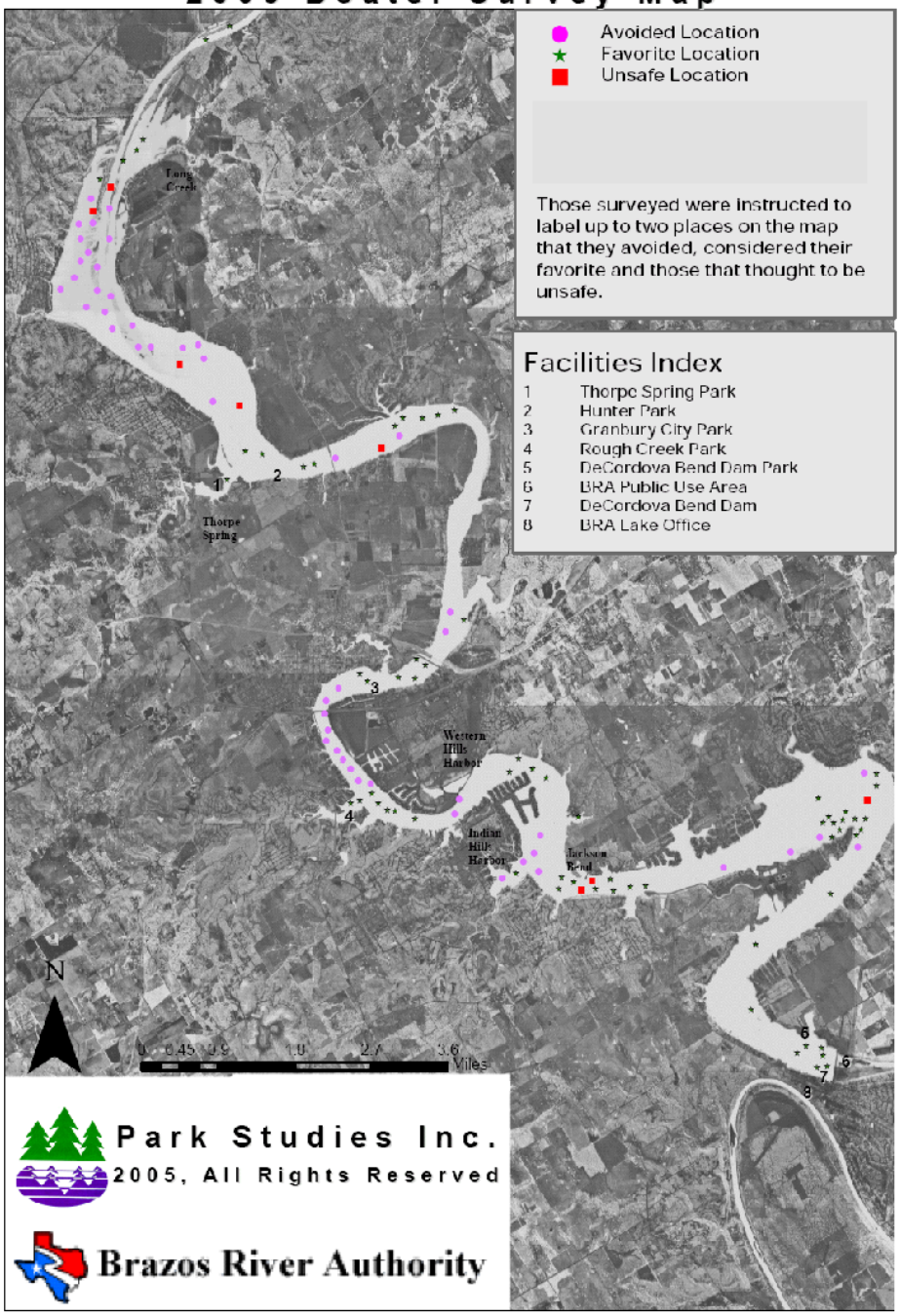
GIS and Boating Capacity

Data collected during the summer of 2005 at Lake Granbury was used to develop classification maps for lake managers to consult. Each dataset was mapped and allowed easy visualization of conflict and boat density. Arc View 9™ and Microsoft Excel™ were the main software used in analysis.

Data was collected by two types of surveys at each lake – one mailed set of surveys and the set from exit interviews on the boat ramps. A conflict map was developed for each survey type to show the location of areas that boaters considered their favorite, unsafe, or areas that they avoided. This map is used to develop a conflict rating for each management compartment.

Lake Granbury

2005 Boater Survey Map



Conflict percentages were derived from responses from boaters surveyed. Avoided and unsafe responses were regarded as areas of conflict. Favorite responses were not considered conflict areas. 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 found from scheduled boat counts. Each lake was divided into four zones. Lake Rangers and data collectors made four counts in each zone – two on weekdays and two on weekend days. Counts were also conducted on July 3. The location and type of each boat were documented on maps by hand.

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

Table 6: Management Compartment Classification Criteria Matrix

Use Level	Incidence of Conflict		
	High	Moderate	Low
Very High	I	I	III
High	I	I	II / III
Moderate	I	II	II
Low	II	II	IV
Very Low	II	II	IV

To find the final classification for each management compartment, density levels and conflict levels were looked at in combination. Classifications were based on the matrix (Table 6).

Table7: Time Period Influence on Maps A & B

Time Period	Weighted Influence	
	Map A	Map B
Weekdays (2 days)	33.3%	25% (12.5%x2days)
Weekends (2 days)	66.7%	50% (25%x2days)
July 3	0	25%

Management compartment density was found in two ways. Map A uses only data from scheduled counts (excludes July 3) with a 66.7% weight for weekends and 33.3% for weekdays (Table 7). Map B includes data from July 3. Each weekend day contributed 25% for a weighted influence of 50%. Each weekday contributed 12.5% for a weighted influence of 25%. July 3 counted for 25% and only contributed to Map B. Map A is shown here as the recommended map for LG while Map B is provided in Appendix B. Although it was mentioned by respondents that 2005 may have been a low use year for boating in the region, no hard evidence was found to support that assumption; therefore Map A remained the recommended map.

To find the final classification for each management compartment, density levels and conflict levels were examined in combination. After classifications were found, maps were developed for the lake, for each scenario (Maps A and B), including maps based on projected increases in density (20%, 40%, 60%, 80%, and 100%) for the lake.

Table 8: 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.

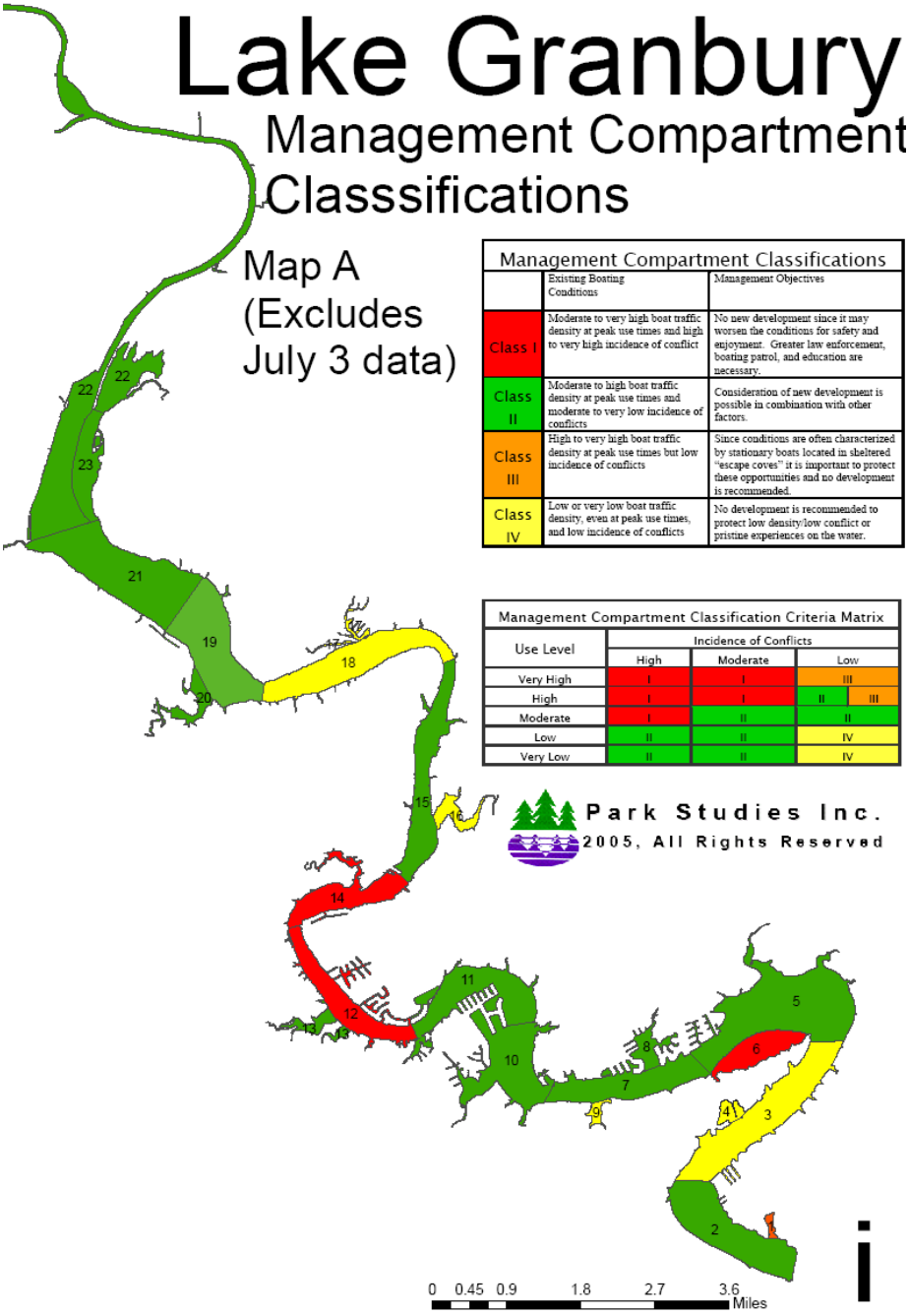
Lake Granbury

Management Compartment Classsifications

Map A (Excludes July 3 data)

Management Compartment Classifications		
	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 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 conflicts	Consideration of new development is possible in combination with other factors.
Class III	High to very high boat traffic density at peak use times but low incidence of conflicts	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 conflicts	No development is recommended to protect low density/low conflict or pristine experiences on the water.

Management Compartment Classification Criteria Matrix			
Use Level	Incidence of Conflicts		
	High	Moderate	Low
Very High	I	I	III
High	I	I	II III
Moderate	I	II	II
Low	II	II	IV
Very Low	II	II	IV



On-The-Water Boat Counts

As an alternative to costly and weather-limited aerial photography as a means of measuring boating activity, boat counts were conducted from a boat traveling the length of the study area. The scheduling of boat counts on Lake Granbury was done to meet the standard for this procedure.

Boat Count Routes

The count boat was operated by a Lake Ranger while the recorder marked the location of boats on the lake on a map. In addition to location, 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. Occasionally, the boat count progress down the lake was interrupted by the Lake Ranger's need to respond to some law enforcement problem.

The total number of boats observed during each count and numbers of watercraft of different types were tallied later from the maps. The count data from the maps were transferred to Microsoft Excel™ software.

3. Results

Introduction

This section of the report presents the results of both boater surveys. A wide variety of baseline information about the boaters utilizing the lake was obtained through these efforts. 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 frequencies, 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 compare future changes. Subsequent monitoring, using similar survey methods, 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 lake 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 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, 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.

Survey Response Rates

Mail-back Surveys. A total of 123 ramp user surveys were administered at public boat ramps. 800 surveys were mailed to a sample of marina slip renters and private dock owners. There were 649 valid surveys and 43% (281) were returned. The total sample size was 404 boaters. Addresses were re-checked for accuracy on all undelivered questionnaires. Response rates should achieve close to 50% as a requirement for sound science.

Descriptive Statistics for Ramp Users

For these tables, the information is presented as a summary following the section. Missing refers to questions that the respondent did not answer on the survey thereby reducing the valid sample size for the purpose of analysis.

Lake Granbury Ramp

	N	Minimum	Maximum	Mean	Std. Deviation
Year boating LG	120	.0	40.0	9.643	9.8566
Number of weekend days boating last year	118	0	104	16.60	21.518
Number of week days boating last year	120	0	200	15.63	28.423
Feet	122	6.00	25.20	17.6967	4.30782
HP	114	4	950	180.26	138.454
Valid N (listwise)	107				

Male or Female

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	105	84.7	86.1	86.1
	Female	16	12.9	13.1	99.2
	Total	122	98.4	100.0	
Missing	System	2	1.6		
Total		124	100.0		

Ever Boated at LG

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	12	9.7	9.8	9.8
	Yes	111	89.5	90.2	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Size of Party Today

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	12	9.7	9.8	9.8
	2	49	39.5	39.8	49.6
	3	17	13.7	13.8	63.4
	4	16	12.9	13.0	76.4
	5	9	7.3	7.3	83.7
	6	8	6.5	6.5	90.2
	7	4	3.2	3.3	93.5
	8	3	2.4	2.4	95.9
	9	2	1.6	1.6	97.6
	15	1	.8	.8	98.4
	22	1	.8	.8	99.2
	30	1	.8	.8	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Number of Days for this Visit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	100	80.6	81.3	81.3
	2	16	12.9	13.0	94.3
	3	3	2.4	2.4	96.7
	4	1	.8	.8	97.6
	7	2	1.6	1.6	99.2
	10	1	.8	.8	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Runabout/Speedboat/Skiboat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	75	60.5	60.5	60.5
	Yes	49	39.5	39.5	100.0
	Total	124	100.0	100.0	

Fishing/Bass Boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	84	67.7	67.7	67.7
	Yes	40	32.3	32.3	100.0
	Total	124	100.0	100.0	

Pontoon Boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	110	88.7	88.7	88.7
	Yes	14	11.3	11.3	100.0
	Total	124	100.0	100.0	

Personal Watercraft

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	106	85.5	85.5	85.5
	1	18	14.5	14.5	100.0
	Total	124	100.0	100.0	

High Performance Boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	123	99.2	99.2	99.2
	Yes	1	.8	.8	100.0
	Total	124	100.0	100.0	

House Boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	123	99.2	99.2	99.2
	Yes	1	.8	.8	100.0
	Total	124	100.0	100.0	

Percent Time Fishing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	87	70.2	70.2	70.2
	1	1	.8	.8	71.0
	5	1	.8	.8	71.8
	10	1	.8	.8	72.6
	20	1	.8	.8	73.4
	25	2	1.6	1.6	75.0
	33	1	.8	.8	75.8
	40	1	.8	.8	76.6
	50	3	2.4	2.4	79.0
	66	1	.8	.8	79.8
	80	1	.8	.8	80.6
	90	1	.8	.8	81.5
	100	23	18.5	18.5	100.0
	Total	124	100.0	100.0	

Percent Time Cruising

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	77	62.1	62.1	62.1
	5	1	.8	.8	62.9
	10	3	2.4	2.4	65.3
	20	2	1.6	1.6	66.9
	25	3	2.4	2.4	69.4
	30	2	1.6	1.6	71.0
	33	2	1.6	1.6	72.6
	40	1	.8	.8	73.4
	45	1	.8	.8	74.2
	50	12	9.7	9.7	83.9
	60	2	1.6	1.6	85.5
	67	1	.8	.8	86.3
	80	1	.8	.8	87.1
	95	1	.8	.8	87.9
	99	1	.8	.8	88.7
	100	14	11.3	11.3	100.0
	Total	124	100.0	100.0	

Percent Time Water-Skiing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	79	63.7	63.7	63.7
	20	2	1.6	1.6	65.3
	25	1	.8	.8	66.1
	30	2	1.6	1.6	67.7
	33	1	.8	.8	68.5
	40	2	1.6	1.6	70.2
	50	10	8.1	8.1	78.2
	70	1	.8	.8	79.0
	75	3	2.4	2.4	81.5
	80	1	.8	.8	82.3
	90	2	1.6	1.6	83.9
	95	2	1.6	1.6	85.5
	100	18	14.5	14.5	100.0
	Total	124	100.0	100.0	

Percent Time Personal Watercraft

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	111	89.5	89.5	89.5
	40	1	.8	.8	90.3
	75	1	.8	.8	91.1
	90	2	1.6	1.6	92.7
	100	9	7.3	7.3	100.0
	Total	124	100.0	100.0	

Percent Time Swimming

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	94	75.8	75.8	75.8
	5	2	1.6	1.6	77.4
	10	3	2.4	2.4	79.8
	15	1	.8	.8	80.6
	20	4	3.2	3.2	83.9
	25	4	3.2	3.2	87.1
	34	1	.8	.8	87.9
	50	9	7.3	7.3	95.2
	67	1	.8	.8	96.0
	75	2	1.6	1.6	97.6
	80	1	.8	.8	98.4
	90	1	.8	.8	99.2
	100	1	.8	.8	100.0
	Total	124	100.0	100.0	100.0

Percent Time Relaxing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	111	89.5	89.5	89.5
	5	1	.8	.8	90.3
	20	3	2.4	2.4	92.7
	25	1	.8	.8	93.5
	33	1	.8	.8	94.4
	50	6	4.8	4.8	99.2
	100	1	.8	.8	100.0
	Total	124	100.0	100.0	

Percent Time Other Activity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	121	97.6	97.6	97.6
	100	3	2.4	2.4	100.0
	Total	124	100.0	100.0	

Favorite Location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	33	26.6	26.8	26.8
	Yes	90	72.6	73.2	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Any Place You Deliberately Avoid?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	48	38.7	39.0	39.0
	1	75	60.5	61.0	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Any Place You Feel Unsafe On Lake?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	75	60.5	61.0	61.0
	1	48	38.7	39.0	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Feel Safe at Boat Ramp

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Safe	1	.8	.8	.8
	Somewhat Safe	9	7.3	7.3	8.1
	Moderately Safe	29	23.4	23.6	31.7
	Extremely Safe	84	67.7	68.3	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Feel Safe on Water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Safe	4	3.2	3.3	3.3
	Somewhat Safe	14	11.3	11.5	14.8
	Moderately Safe	41	33.1	33.6	48.4
	Extremely Safe	63	50.8	51.6	100.0
	Total	122	98.4	100.0	
Missing	System	2	1.6		
Total		124	100.0		

Crowded at Ramp

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Crowded	73	58.9	59.3	59.3
	Somewhat Crowded	26	21.0	21.1	80.5
	Moderately Crowded	16	12.9	13.0	93.5
	Extremely Crowded	8	6.5	6.5	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Crowded on Water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Crowded	49	39.5	39.8	39.8
	Somewhat Crowded	23	18.5	18.7	58.5
	Moderately Crowded	37	29.8	30.1	88.6
	Extremely Crowded	14	11.3	11.4	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

Adequate Number of Boat Ramps

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too Many	1	.8	.8	.8
	About Right	69	55.6	57.0	57.9
	Need More	51	41.1	42.1	100.0
	Total	121	97.6	100.0	
Missing	System	3	2.4		
Total		124	100.0		

Adequate Number of Parking Areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too many	1	.8	.8	.8
	About right	75	60.5	62.0	62.8
	Need more	45	36.3	37.2	100.0
	Total	121	97.6	100.0	
Missing	System	3	2.4		
Total		124	100.0		

Adequate Number of Marinas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	About right	75	60.5	62.0	62.0
	Need more	46	37.1	38.0	100.0
	Total	121	97.6	100.0	
Missing	System	3	2.4		
Total		124	100.0		

Positive or Negative

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Negative Change	46	37.1	37.4	37.4
	No Change	46	37.1	37.4	74.8
	Both Negative and Positive Change	8	6.5	6.5	81.3
	Positive Change	23	18.5	18.7	100.0
	Total	123	99.2	100.0	
Missing	System	1	.8		
Total		124	100.0		

State of Origin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		1	.8	.8	.8
	LA	1	.8	.8	1.6
	OK	1	.8	.8	2.4
	TX	121	97.6	97.6	100.0
	Total	124	100.0	100.0	

Descriptive Statistics for Marina/Dock Users

Lake Granbury Marina/Dock Boaters

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Year boating LG	251	35	0	35	2751	10.96	9.097	82.752
Number of weekend days boating last year	266	1020	0	1020	5185	19.49	64.280	4131.941
Number of week days boating last year	253	261	0	261	4419	17.47	31.450	989.123
Feet	274	27.00	.00	27.00	5335.70	19.4734	3.45974	11.970
HP	261	2000	0	2000	40689	155.90	143.343	20547.178
Valid N	213							

Have you boated on this lake before this visit?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	36	12.8	18.3	18.3
	Yes	161	57.3	81.7	100.0
	Total	197	70.1	100.0	
Missing	System	84	29.9		
Total		281	100.0		

Runabout/Speedboat/Ski boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	155	55.2	55.4	55.4
	Yes	125	44.5	44.6	100.0
	Total	280	99.6	100.0	
Missing	System	1	.4		
Total		281	100.0		

Fishing/Bass Boat

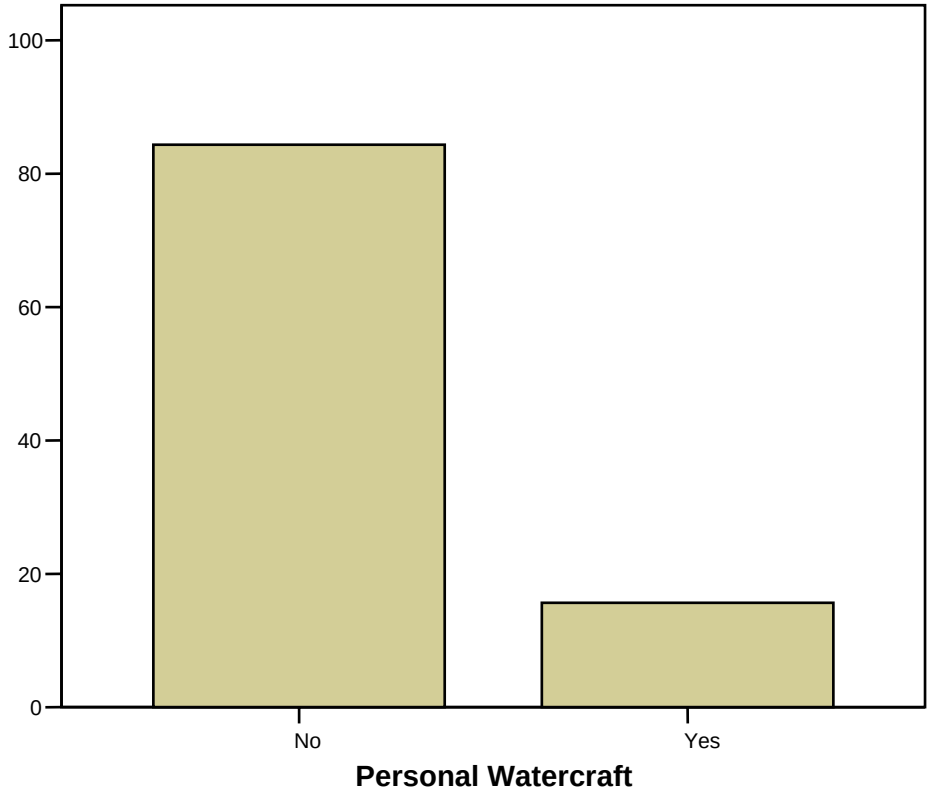
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	223	79.4	79.4	79.4
	Yes	58	20.6	20.6	100.0
	Total	281	100.0	100.0	

Pontoon Boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	206	73.3	73.3	73.3
	Yes	75	26.7	26.7	100.0
	Total	281	100.0	100.0	

Personal Watercraft

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	237	84.3	84.3	84.3
	1	44	15.7	15.7	100.0
	Total	281	100.0	100.0	



High Performance Boat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	278	98.9	98.9	98.9
	Yes	3	1.1	1.1	100.0
	Total	281	100.0	100.0	

Cabin Cruiser

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	277	98.6	98.6	98.6
	Yes	4	1.4	1.4	100.0
	Total	281	100.0	100.0	

Flatbottom/Jonboat V Hull

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	272	96.8	96.8	96.8
	Yes	9	3.2	3.2	100.0
	Total	281	100.0	100.0	

Sailboat/Sailboard

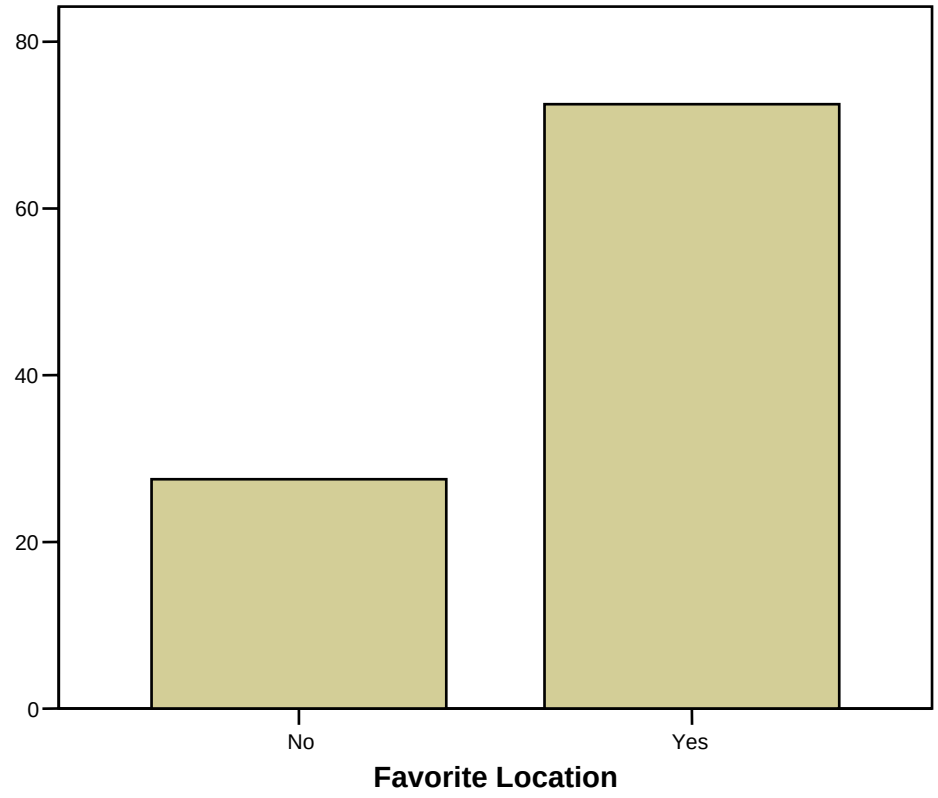
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	278	98.9	98.9	98.9
	Yes	3	1.1	1.1	100.0
	Total	281	100.0	100.0	

Other Boat Type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	262	93.2	93.2	93.2
	Yes	19	6.8	6.8	100.0
	Total	281	100.0	100.0	

Favorite Location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	77	27.4	27.5	27.5
	Yes	203	72.2	72.5	100.0
	Total	280	99.6	100.0	
Missing	System	1	.4		
Total		281	100.0		



Any Place You Deliberately Avoid?

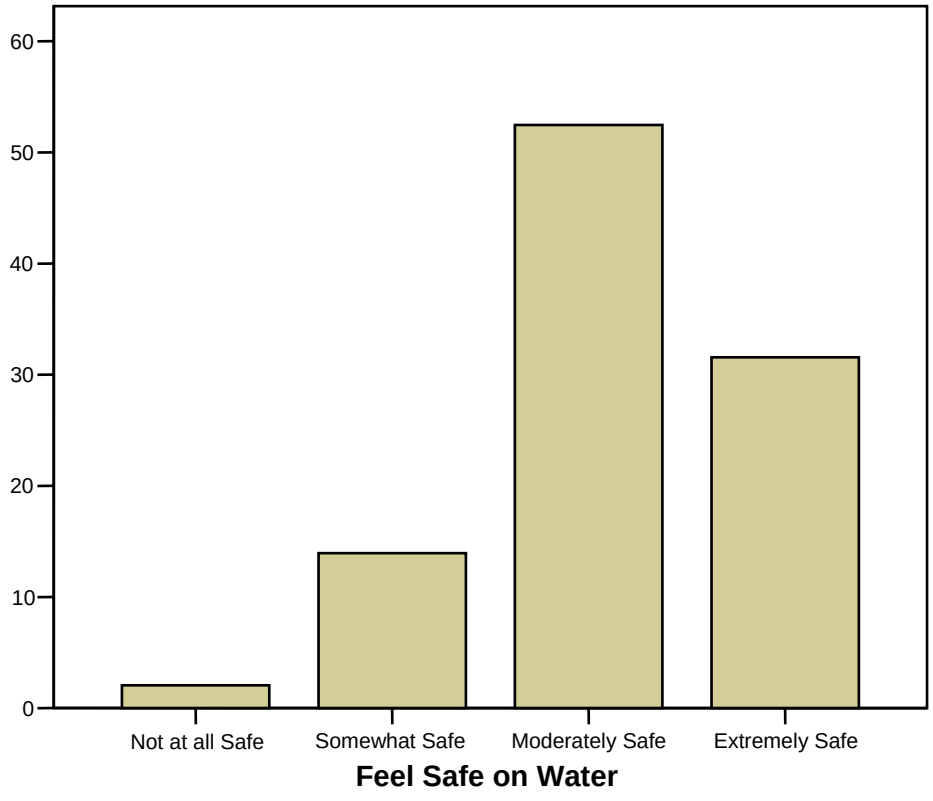
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	86	30.6	31.3	31.3
	1	189	67.3	68.7	100.0
	Total	275	97.9	100.0	
Missing	System	6	2.1		
Total		281	100.0		

Any Place You Feel Unsafe On Lake?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	129	45.9	48.0	48.0
	1	140	49.8	52.0	100.0
	Total	269	95.7	100.0	
Missing	System	12	4.3		
Total		281	100.0		

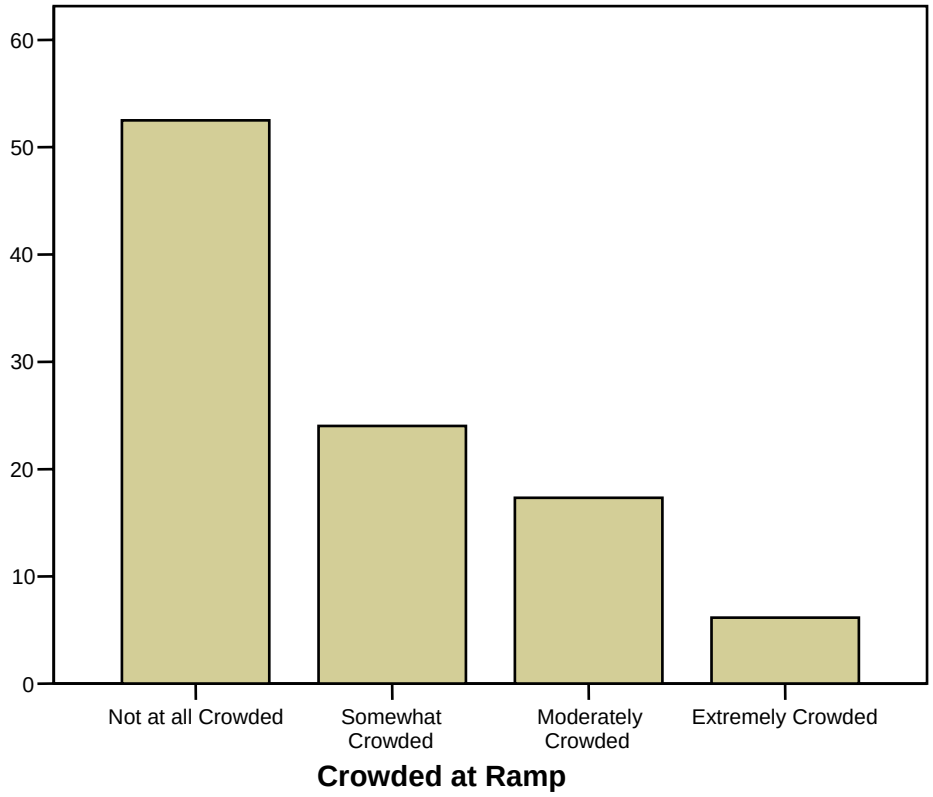
Feel Safe on Water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Safe	5	1.8	2.0	2.0
	Somewhat Safe	34	12.1	13.9	16.0
	Moderately Safe	128	45.6	52.5	68.4
	Extremely Safe	77	27.4	31.6	100.0
	Total	244	86.8	100.0	
Missing	System	37	13.2		
Total		281	100.0		



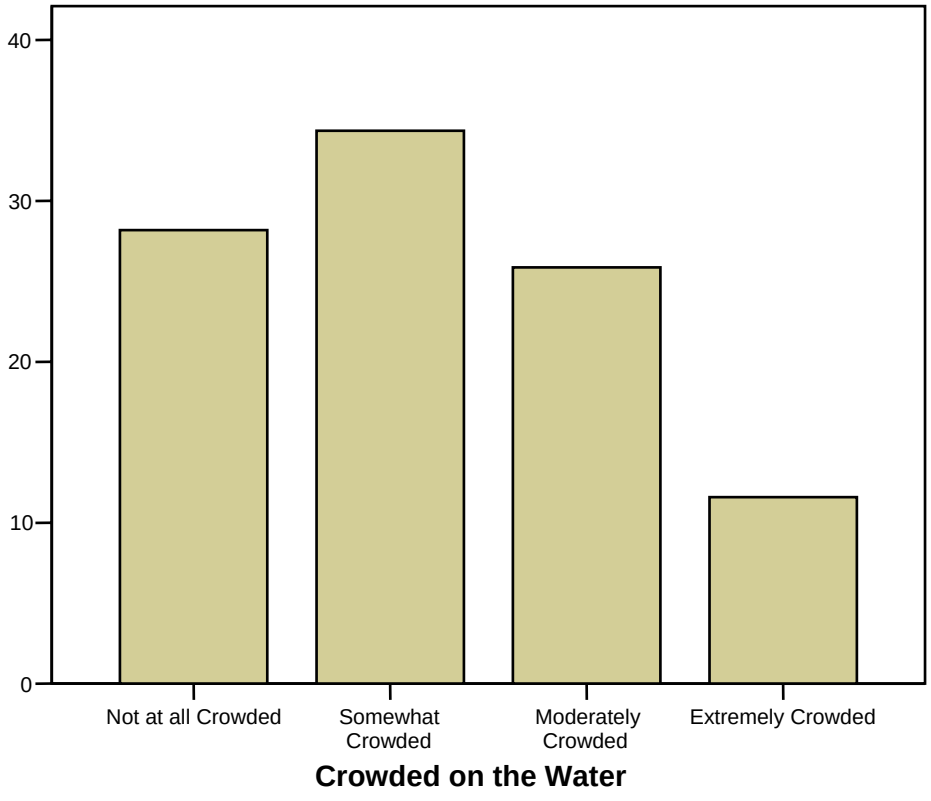
Crowded at Ramp

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Crowded	94	33.5	52.5	52.5
	Somewhat Crowded	43	15.3	24.0	76.5
	Moderately Crowded	31	11.0	17.3	93.9
	Extremely Crowded	11	3.9	6.1	100.0
	Total	179	63.7	100.0	
Missing	System	102	36.3		
Total		281	100.0		



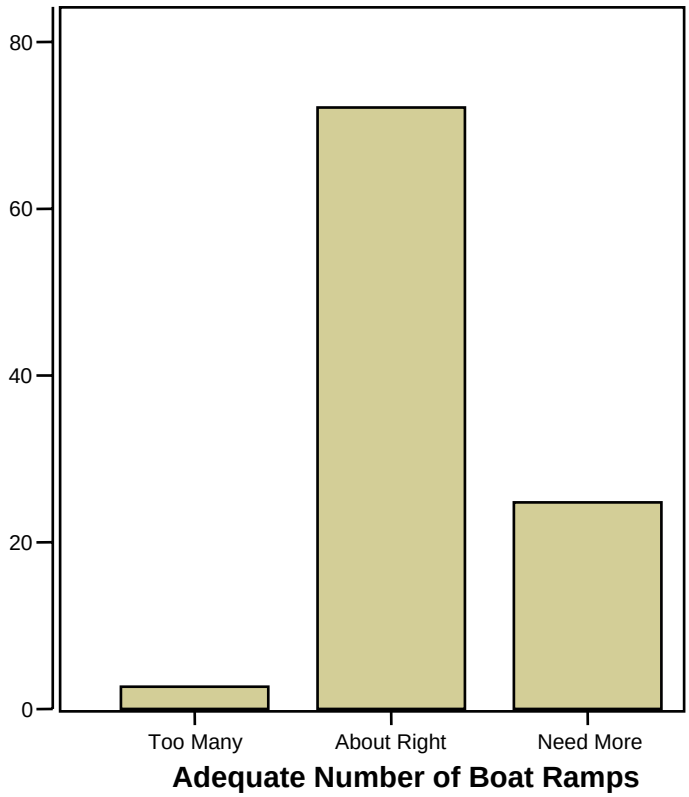
Crowded on the Water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all Crowded	73	26.0	28.2	28.2
	Somewhat Crowded	89	31.7	34.4	62.5
	Moderately Crowded	67	23.8	25.9	88.4
	Extremely Crowded	30	10.7	11.6	100.0
	Total	259	92.2	100.0	
Missing	System	22	7.8		
Total		281	100.0		



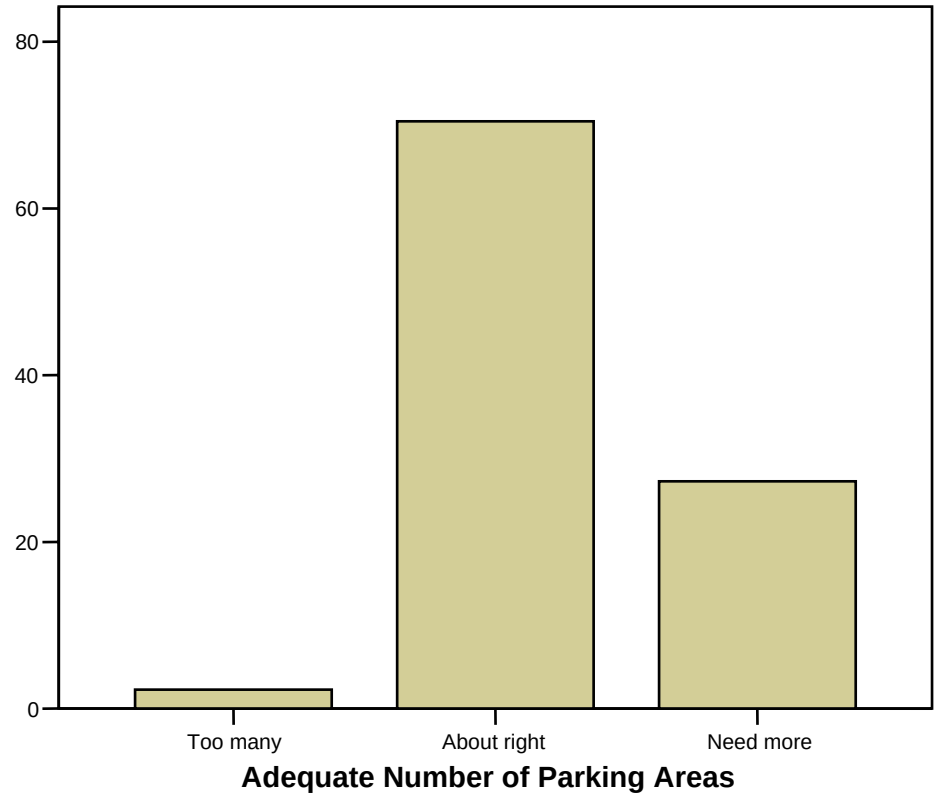
Adequate Number of Boat Ramps

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too Many	6	2.1	2.7	2.7
	About Right	163	58.0	72.1	74.8
	Need More	56	19.9	24.8	99.6
	22	1	.4	.4	100.0
	Total	226	80.4	100.0	
Missing	System	55	19.6		
Total		281	100.0		



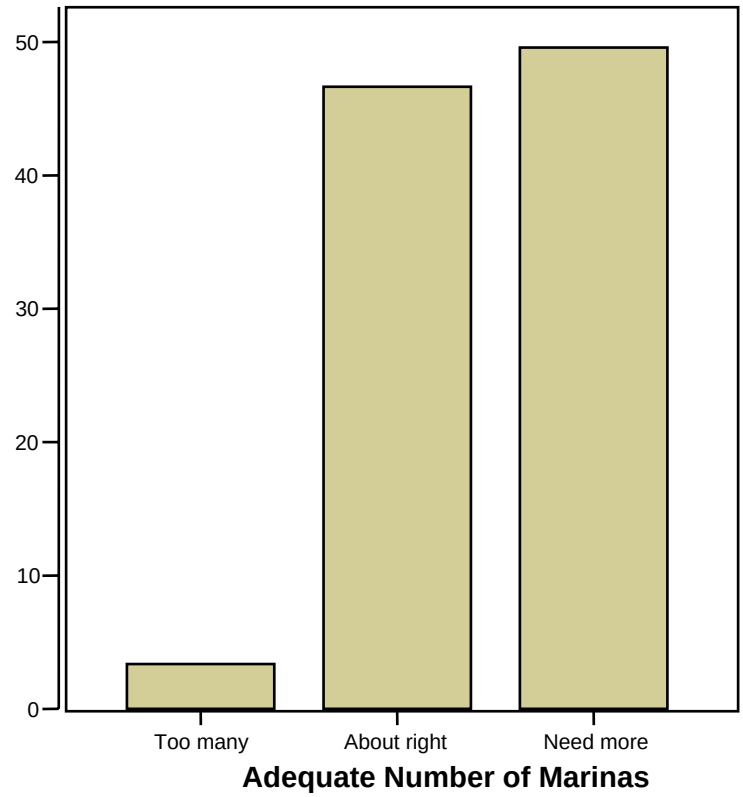
Adequate Number of Parking Areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too many	5	1.8	2.3	2.3
	About right	155	55.2	70.5	72.7
	Need more	60	21.4	27.3	100.0
	Total	220	78.3	100.0	
Missing	System	61	21.7		
Total		281	100.0		



Adequate Number of Marinas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too many	8	2.8	3.4	3.4
	About right	111	39.5	46.6	50.0
	Need more	118	42.0	49.6	99.6
	5	1	.4	.4	100.0
	Total	238	84.7	100.0	
Missing	System	43	15.3		
Total		281	100.0		



Positive or Negative Changes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Negative Change	114	40.6	40.9	40.9
	No Change	98	34.9	35.1	76.0
	Both Negative and Positive Change	55	19.6	19.7	95.7
	Positive Change	12	4.3	4.3	100.0
	Total	279	99.3	100.0	
Missing	System	2	.7		
Total		281	100.0		

4. Discussion

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.

Overall Data Summary

A majority of boaters are returning to LG each year. Boat ramp users have been returning as long as marina slip' renters and private dock owners. Boat ramp users spend just a few days less on the lake as the other group. The length and horsepower of boats is about the same for both marina/dock users and ramp users.

All three boater groups felt safe on the water; however the marina/dock group was more sensitive to crowding on the water. Both groups felt that the number of marinas was about right; however the marina/dock group indicated a need for more. Both groups had favorite locations on the lake as well as places they avoided. In terms of law enforcement; some say more is needed while others say there is too much. The differences have much to do with location versus the entire lake.

For that reason, this study sought to discuss the lake in both broad terms and location specific terms leading to recommendations. The data created here is a baseline or “snapshot” in time. Monitoring should occur every 3-5 years and budgeted accordingly to take advantage of trends, challenges, and changing conditions in meeting the agency goals for improved stewardship and the ability to provide safe and enjoyable opportunities now and in the future.

Management Compartment Classification and Percent Projections Summary

Based on experiences with other lakes, it was surprising that GL did not exhibit more areas in the red and less areas in the green classification. At first glance it would appear that the lake has few problems; however the percentages indicating a moderately crowded condition along with the comments about behavior on the lake suggest a different scenario. Furthermore, it was noted that many of the classified compartments were very borderline based on low conflicts suggesting that an increase in conflicts could push the classifications toward more restrictive measures. It was noted by respondents that it may have been a low use year but data were not available to test that assumption.

The series of maps projecting use into the future serve as a diagnostic tool from which to evaluate proposed developments, direct Lake Ranger activities, and provide a format for further discussion with local officials. These projections are conservative since conflicts were held constant.

Managers are encouraged to continue collecting accident data as well as head count data. These two sources of information proved indispensable in corroborating the classification maps and ultimately supporting the recommendations.

Overall Recommendations

- Do not worsen crowding/conflict problems---work to mitigate these problems where they exist with alternatives.
- No further development in management compartments I, III, and IV that would result in additional boating density and potential conflicts in those areas.
- Preserve the diversity of recreation opportunities within different parts of the lake with special attention to protecting low use areas and/or "escape" coves.
- Based on responses from the surveys and the public workshops, it is recommended that additional lake ranger personnel be added to Lake Granbury to address public health and safety.

Specific Management Recommendations

These recommendations are based on cooperating partner workshops, public workshops, e-mail and written correspondence, and consultant experience.

- Resolution necessary to address existing conflict of boat traffic, economic development, and environmental concerns
- Establish no-wake zones, special use zones, and restricted areas as appropriate
- Continue to install and number lighted centerline buoy markers
- Obstacle identification/selective reduction for public safety
- Develop standards for docks and retaining walls in conjunction with county and city
- City and county explore shoreline buffers
- Seek improvement opportunities for BRA public use areas

5. Literature Cited

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