

# CANYON LAKE CARRYING CAPACITY STUDY

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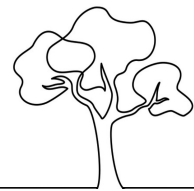
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# Canyon Lake Carrying Capacity Study

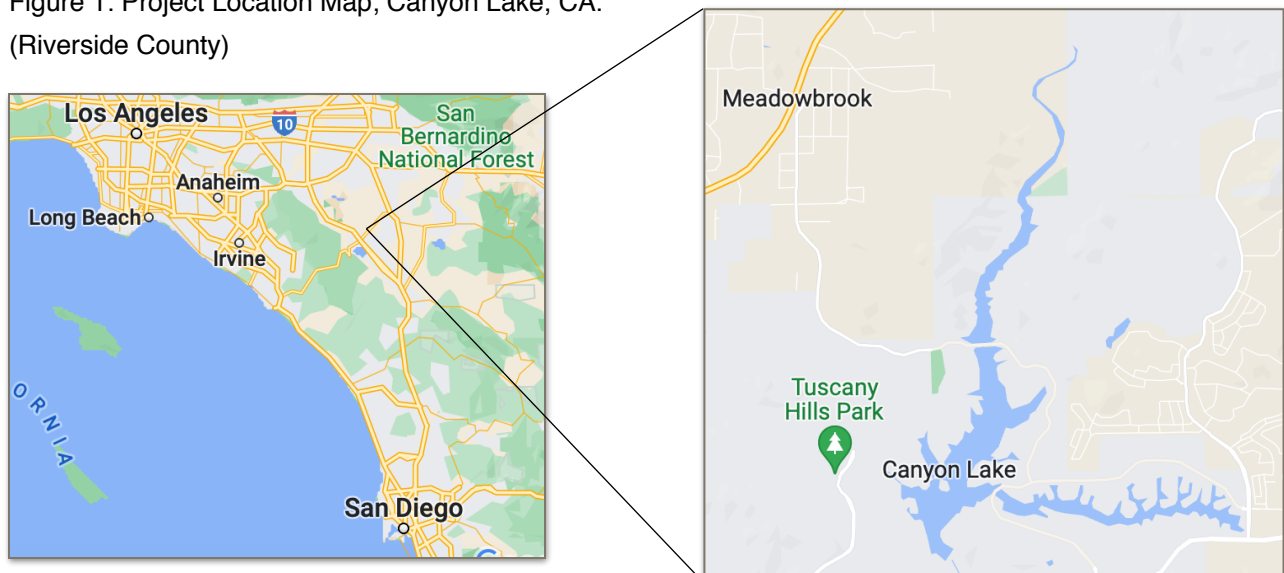
## Introduction

Across the world motorized boating has become one of the fastest growing forms of outdoor recreation. Spurred in part by Covid-19 pandemic requirements for social distancing, which led to millions of people discovering new forms of outdoor recreation, U.S. motorized boat sales reached a 13 year high in 2020 with over 310,00 new units sold<sup>1</sup>. This trend is expected to continue and sales of wake boats, a popular option for new boat buyers, is one of the fastest growing segments of the industry in the U.S.

The rise in use of wake boats, however, has left resource managers racing to cope with the environmental, social, and economic impacts posed by this rapidly evolving technology. From reassessing no-wake zones to adding minimum operating depth requirements, the range of mitigation options has also been rapidly growing to meet changing demands. The Canyon Lake Property Owners Association (CLPOA), which holds administrative authority over the community of Canyon Lake, California, and Railroad Canyon Reservoir (Canyon Lake) is one of the many jurisdictions that has chosen to revisit their lake regulations due to changes in use patterns.

With a community of 15,000 residents, 4,800 houses, and nearly 2,000 registered motorized watercraft, Canyon Lake is a recreation focused community. Lake use is moderate to heavy year-round compared to similar bodies of water and holiday weekends are exceptionally crowded. Use is also highly varied, ranging from swimming and stand-up-paddle boarding to fishing and wake sports. Access is ample, with several launch points, nearly 900 individual docks, and hundreds of additional slip spaces around the lake.

Figure 1: Project Location Map; Canyon Lake, CA.  
(Riverside County)



## Area & Lake Characteristics

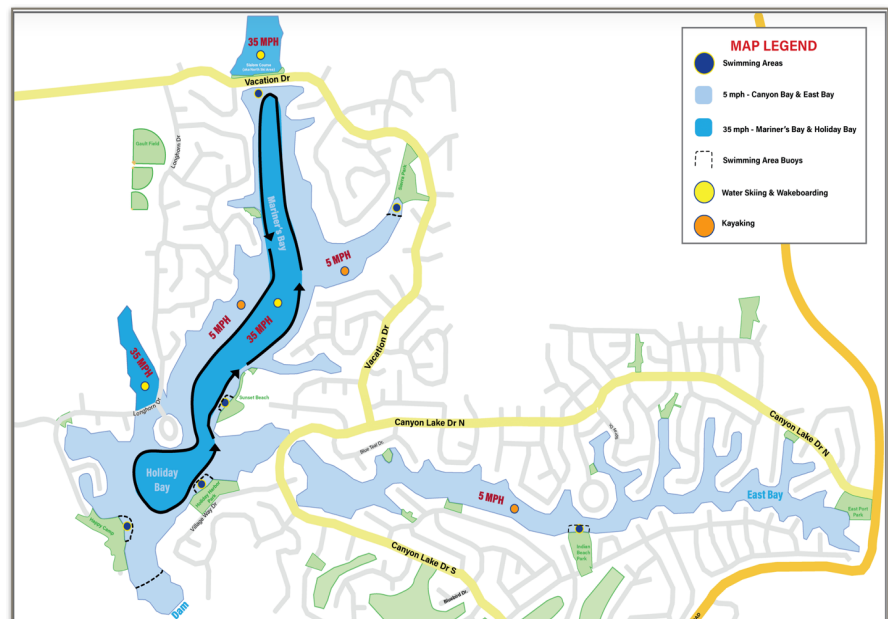
Canyon Lake lies in the highly urbanized foothills of Southern California, and is owned and operated by the Elsinore Valley Municipal Water District to provide drinking water to surrounding communities. Just over 500 acres of surface rights are leased to the Canyon Lake Property Owners Association (CLPOA), which manages the main body of the reservoir for recreation purposes. The entire lakefront within the CLPOA management area is developed, and the surrounding area is also highly urbanized. Gates restrict access to the Canyon Lake community and non-residents are generally not allowed to recreate on the lake.

Canyon Lake has a storage capacity of 11,586 acre feet and is fed primarily by the San Jacinto River and Salt Creek. The lake is subject to excess nutrient runoff from the surrounding watershed and residential community, and alum is applied regularly to reduce phosphorus loads in the water column. Alum treatments began in 2013, and have occurred 18 times to date. The treatments are expected to continue indefinitely and are contracted to a third party by the Santa Ana Watershed Project Authority.

## Review of Existing Boating Regulations

Recreational use of Canyon Lake is highly regulated and all motorized watercraft must be registered with the CLPOA. Boats over 21.5', ballast, and personal watercraft (i.e. jet skis) are not allowed, and much of the lake has a 5 mph speed limit and no-wake restriction. A narrow strip in the main body of the lake, encompassing approximately 75 acres, is reserved for towed watersports with a 35 mph speed limit. Boats engaging in towed water sports must travel in a counterclockwise direction and tubing is not allowed.

Figure 2: Map of Canyon Lake Boating Regulations.



Non-towed water sports are allowed in the upper arm of Canyon Lake, north of Vacation Drive. This area has a 35 mph speed limit and also hosts a water ski slalom course. Another small area for water-skiers lies just off the main body of the lake, west of Longhorn Drive. The entire east arm of the lake, east of Canyon Lake Drive, is a 5 mph no-wake zone. While motorized recreation is the predominant use of the lake, there are also several designated swimming areas, and kayaks and paddle boards are also frequently used on the lake.

## **Recreational Carrying Capacity Concept**

Recreational carrying capacity studies for motorized watercraft have appeared in research journals since the 1970's, stemming from both private and public entities. In its most basic sense, a carrying capacity is "the maximum population that an area will support without undergoing deterioration".<sup>2</sup> While typical carrying capacity studies primarily focus on biological and environmental variables, recreational carry capacity studies also consider economic and social variables. Social variables include perceptions of privacy, crowding, and intrinsic natural value, which are highly subjective and vary widely across user groups and settings. In the case of motorized recreation, carrying capacity typically concerns issues of overcrowding and is demonstrated when "conflict(s) arise or when the user chooses to no longer utilize the resource".<sup>3</sup>

Carrying capacity studies for motorized watercraft provide insights into present and future developments in water recreation. These studies analyze use in diverse settings with diverse boat types, utilizing metrics as guides to assess capacity. The relatively few studies performed to date, however, has left room for substantial development in the field. For example, more recent studies have found non-towed wake sports require more acres per boat to foster social acceptability, which can drastically alter use patterns and management requirements on smaller bodies of water such as Canyon Lake.

## **Carrying Capacity Study - Methods**

Existing regulations, shoreline development, and use patterns on Canyon Lake allowed for a streamlined carrying capacity study wherein social variables, rather than economic or environmental factors, played a predominant role in determining optimal boating densities. First, baseline use rates were determined through (a) time-lapse photography, (b) real time watercraft census, and (c) user surveys. These baseline use rates were then translated into a scale to gauge crowdedness, which was represented by simulated photographs of crowding (see next page). Finally, the simulated photos were analyzed by users in a second, in-person survey, and the results of this survey were used to determine optimal boating densities. Due to current use

patterns and regulations, only the main body of the lake (approximately 250 acres), was considered for this study.

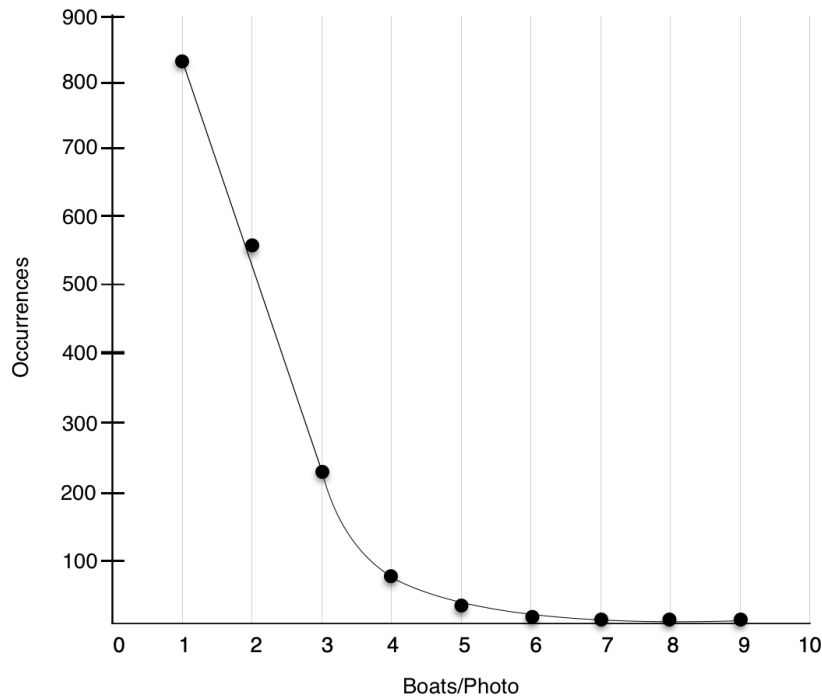
Aggregate use types were also used in the development of this study, wherein all the different motorized user groups on the lake were considered under one optimal boating density. This was possible for two reasons: (a) the relatively small area of the main body of Canyon Lake limits self segregation between user groups, and (b) both of the predominant boat types on Canyon Lake, wake boats and pontoon boats, both routinely engage in wake sports and leisure/cruising (the most popular activities on the lake).

### Time Lapse Photography

From June 17, 2022 to August 26, 2022, two Technaxx TX-164 HD Cameras recorded lake use in Holiday Bay and Mariners Bay. Photos were taken at 10 minute intervals 24 hours a day, and just over 20,000 photos were taken in total. Debris and/or cobwebs covering the lens of the camera in Holiday Bay rendered nearly half of the photos from that area unusable, while the camera in Mariners Bay remained debris free for the duration of the study.

The camera coverage area in Mariners Bay was approximately 30 acres, and extended north to the Vacation Drive causeway (photo examples in Appendix A). Around 80% of the 10,125 total pictures recorded zero boats, while the distribution of boats in the remaining 1,732 photos is shown below. For example, 830 of the total pictures captured one motorized boat, as shown by the point in the upper left side of the graph.

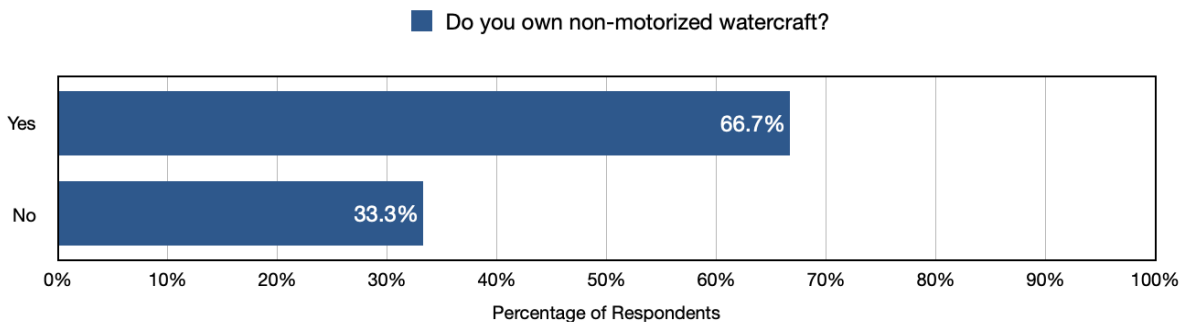
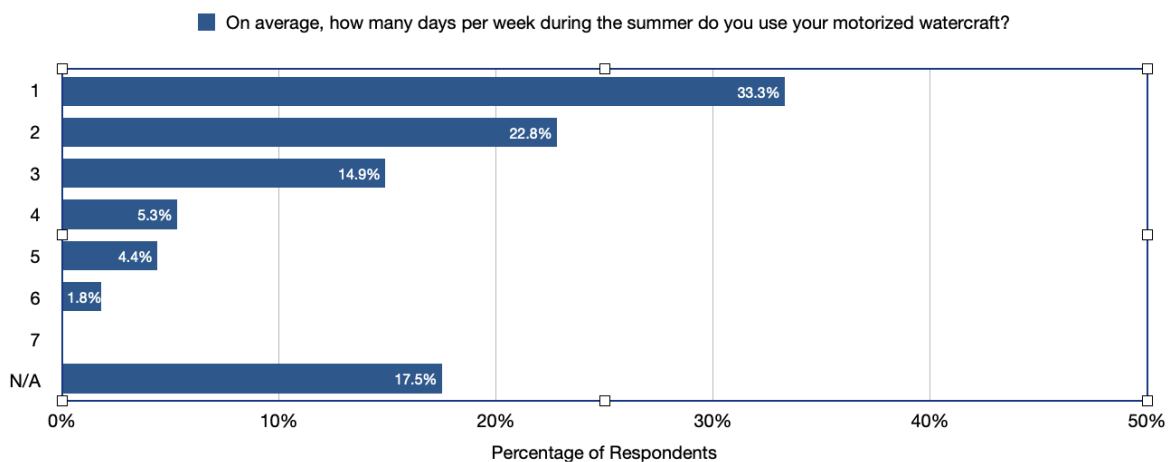
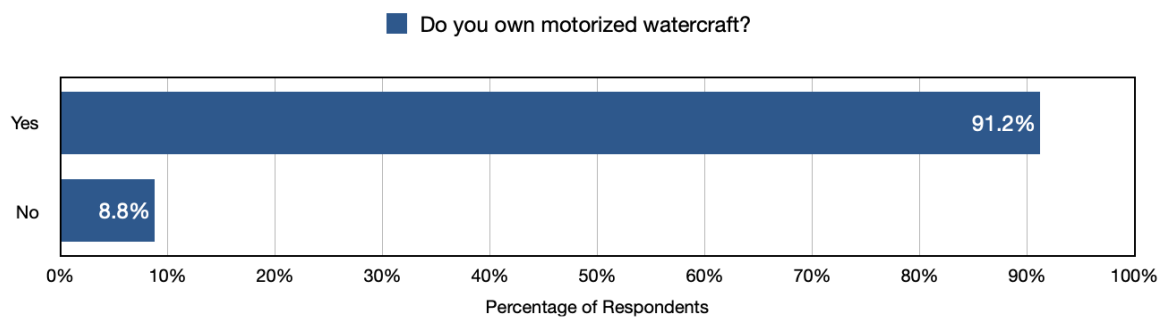
Graph 1: Recorded boat distribution in Mariners Bay (June 17 - August 26, 2022)



## General Perception Survey (Online)

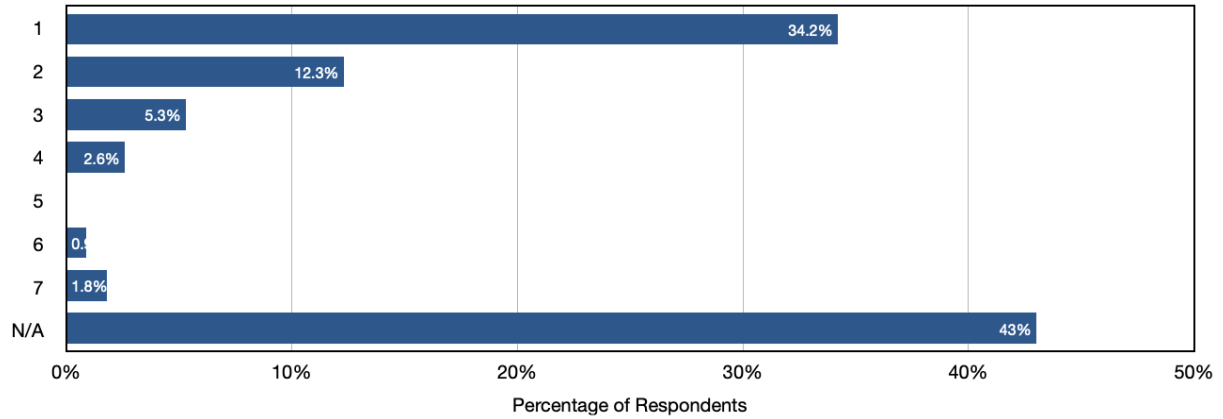
A general perception survey was issued to residents of the Canyon Lake community in early July by e-mail which remained open through the duration of the study period. The survey asked residents several normative questions pertaining to home ownership and boat usage, as well as their general perception of crowding on Canyon Lake. Results of the survey are shown in Charts 1-7 below. A brief analysis of the results shows crowding is a concern for lake users, with 80% of respondents reporting crowding during the summer months and/or popular holidays. Furthermore, 31% of total respondents reported that crowding has impacted their ability to recreate on the water.

Charts 1-7: General Perception Survey Results

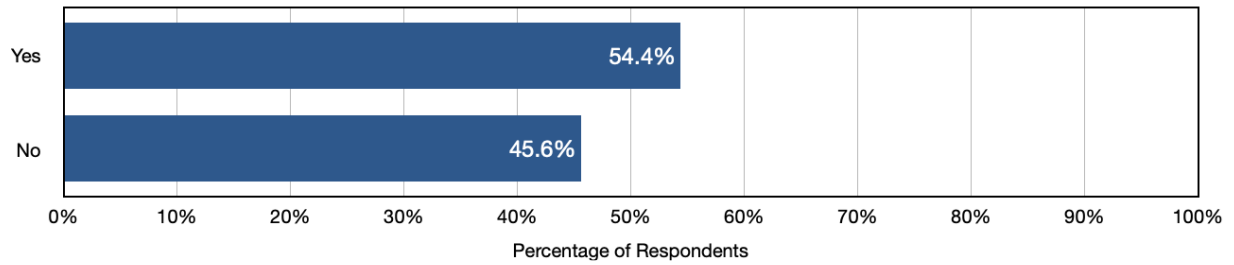




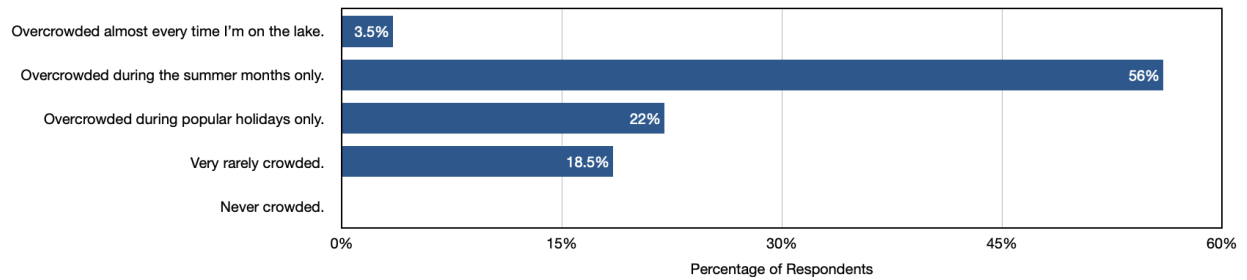
■ On average, how many days per week during the summer do you use your non-motorized watercraft?



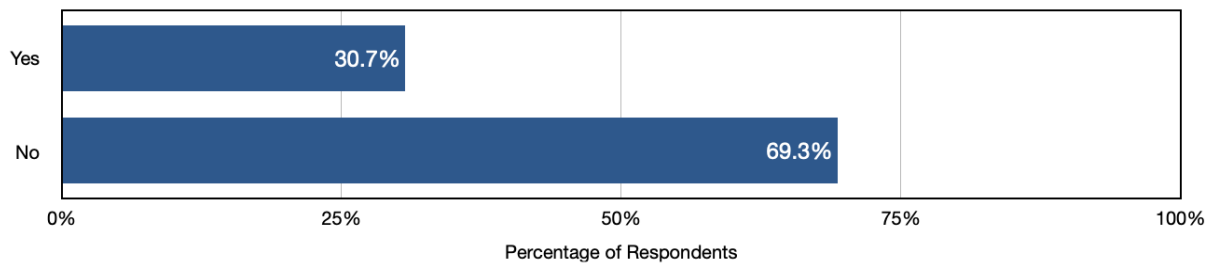
■ Do you own a waterfront home?



■ What is your general opinion about how busy the lake is?



■ Has crowding impacted your ability to recreate on the water?



## On-Lake Watercraft Census

On-lake watercraft census were performed on the main body of the lake periodically from August 26-28. The census were taken from shore, and lake users reported average use for a late summer weekend. The highest count recorded during the aggregate census was 28 motorized watercraft, with the majority of the boats engaged in leisure/cruising activities. Overall this translates to 1 boat / 8.9 acres, which falls at the high end of the range for motorized boating capacities in urban settings (1 boat per 1 - 10 acres).<sup>4</sup> Focused perception surveys were also performed during this period to assess crowding in real time (see below), with 74% of respondents reporting no crowding during the entire survey period, and 91% reporting little to no crowding during the peak use time on Saturday afternoon.

## Focused Perception Surveys (In-Person)

A two part perception survey was conducted in-person during the weekend of August 26-28 and was used to assess perceptions of crowding during that specific weekend. A majority of respondents were surveyed at the Happy Camp gas pump, and a diverse mix of user types were surveyed. First, users were asked about their activities and experiences on the lake, and to gauge crowding at the time of the survey on a five point scale. Second, 5 simulated photos representing crowding at specific levels were shown to lake users, who were then asked to (a) gauge the level of crowding on a scale of 1-7, and (b) indicate at which level they would no longer use the lake. A social norm (regression) curve was then developed from these results which plotted the mean acceptability rating from each of the simulated photographs.

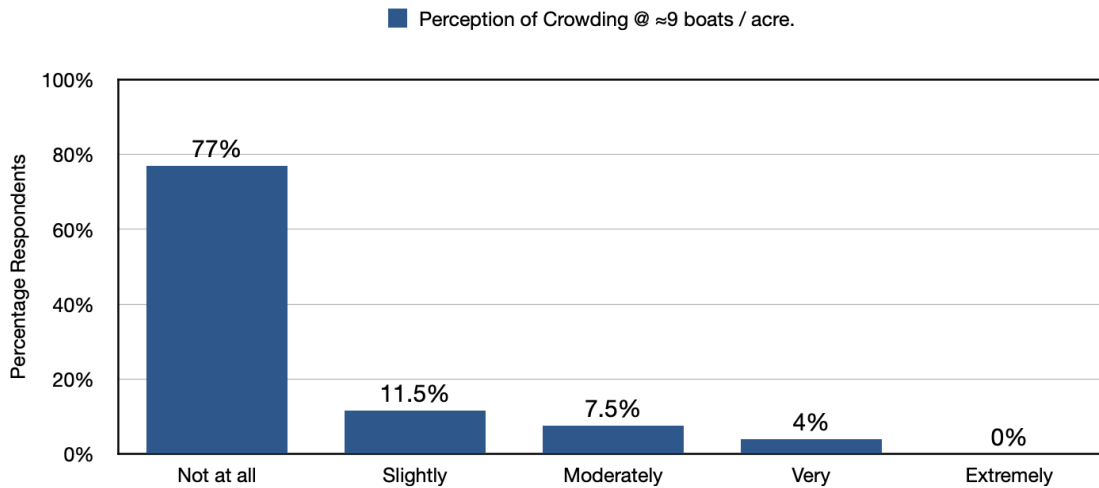
Photo 1: Simulated photo representing use level of  $\approx 7$  acres/boat.



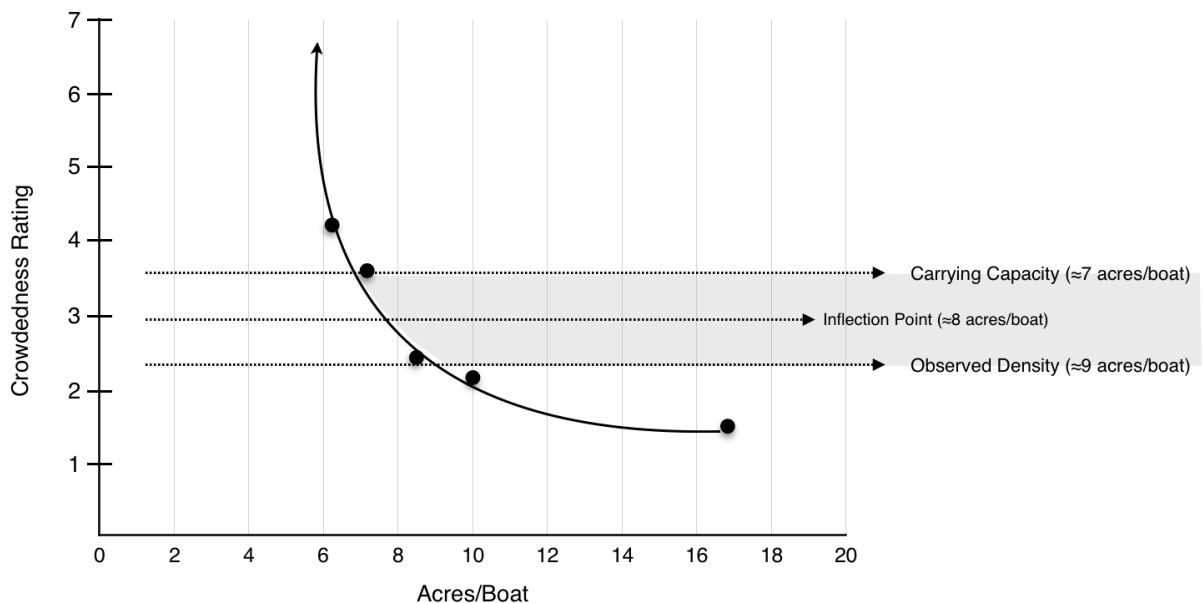
## Carrying Capacity Study - Results

Analysis of the in-person survey results showed 77% of respondents indicated the level of crowding during the survey period was “not at all”, and 11.5% described the crowding as “slight” (Chart 8). These results were similar to the results seen using simulated photographs, where respondents rated equivalent levels of crowding between 1 and 2.5 on a 7 point Likert-type scale (Graph 2). Agreement between these two results suggests carrying capacity was not reached during the August in-person survey period, when maximum observed usage reached approximately 9 acres/boat.

Chart 8 - Crowdedness rating during weekend of August 26-28.



Graph 2 - Social norm curve for crowdedness using simulated photographs.



As shown on Graph 1, respondents from the second survey also reported that crowding became a significant concern around 7 acres/boat, with one respondent reporting they would no longer use the lake at that level. The social norm curve also inflects just below this point, indicating optimal boating densities are found above 8 acres/boat, with a functional carrying capacity on Canyon Lake of approximately 7 acres/boat.

## **Discussion**

Analysis of time-lapse photos, as well as the observed density of approximately 9 acres/boat on a late summer weekend, suggest that carrying capacity is likely reached or exceeded on many weekends during the peak summer months. This is congruent with results from both surveys, where (a) 52% of respondents indicated that crowding occurred “during summer months only”, (b) 22% of respondents indicated crowding occurred “during popular holidays only”, and (c) 31% of total respondents indicated crowding has impacted their ability to recreate on the water.

These results, however, do not necessarily indicate user dissatisfaction, and other findings reveal that exceeding carrying capacity may not necessarily result in conflict or non-use of the lake. During the ‘Survey 2’ period on the weekend of Aug. 26-28, where maximum boating densities reached 9 acres/boat, 76% of users reported their visit as “excellent”, and 24% of users reported their visit as “good”. No visitors reported their experience as “neutral” or “poor”. Furthermore, as observed in the second survey, only one user reported they would not use the lake at a certain level; all other respondents declared they would still use the lake at the most crowded level seen in the simulated photographs.

In a final question in Survey 1 (not shown above), 69% of respondents declared they were “satisfied with current boating regulations on Canyon Lake”. This finding, along with the carrying capacity study results, indicates the status quo surrounding current use levels and regulations are generally favorable to users on the lake, and should be maintained to keep boating densities at or below the carrying capacity.

## **Implications for Future Management**

Preserving the status quo on Canyon Lake, while keeping use under the functional carrying capacity of approximately 7 acres/boat, will likely require several proactive management actions. These include:

1. Long-term monitoring of boating densities - Monitoring of boating densities should occur regularly to stay informed of use trends. These surveys are simple to perform from the water and should occur during both peak and non-peak hours in the main body of the lake.

Indicators that carrying capacity has been exceeded include a decrease in use during peak hours, or an increase in use during non-peak hours.

2. Periodic surveys to gauge user satisfaction - Social indicators will remain the best tool to gauge crowding on Canyon Lake, and normative questions such as those found in Survey 1 of this study can adequately gauge user satisfaction. When implemented in combination with monitoring of boating densities, trends in lake usage will likely be readily apparent.
3. Moratorium on new motorized boat registrations - Implementing a moratorium on new motorized boat registrations in the Canyon Lake Community will help preserve the status quo for boating on the lake. Although the data indicates that some capacity remains for additional users on the lake, it also indicates user satisfaction may begin to decrease rapidly with an increase in use. Long term surveys of boating densities and user satisfaction are needed to determine the extent of a moratorium if this action is under consideration.
4. Adoption of a limit on boat weights - See below.

### **Boat Weight Limit**

Considering the use patterns and existing regulations on Canyon Lake, physical parameters of the lake itself, and recreation trends, implementation of a maximum dry boat weight limit of 5,000 pounds is recommended with the following justifications:

1. One of the fastest growing sectors in the motorized boat market is wake boats<sup>1</sup>, which are designed specifically to create large wakes. As these boats trend larger and heavier, and they create more displacement, their potential to create larger wakes also increases. The effects of large wakes on smaller bodies of water such as Canyon Lake are well documented and include:
  - a) Degradation and erosion of shorelines;<sup>5,6,7</sup> Larger and heavier boats will cause larger wakes with more potential energy. Although substantial sections of Canyon Lake feature hardened shorelines, many areas are still susceptible to erosion and beach loss. These include the Happy Camp beach, where erosion from wave action can be seen around the concrete pad at the gas pumps, and Sunset Beach, where erosion from wave action and wave deflection can be seen at the north end of the seawall below the swimming pool. Shoreline erosion can be further exacerbated by seawalls, as energy is deflected rather than absorbed. Other negative effects of shoreline erosion include turbidity and nutrient release into the water column, which degrades overall water quality

and the intrinsic value of the lake, while increasing the potential for harmful algae blooms.

b) Impacts to economic resources;<sup>8,9</sup> Many docks, piers, and buoys are not designed to withstand the energy imparted from the large wakes produced by wake boats, and reports of damage to structures and moored boats is increasing with the growing use of wake boats. As wake boats trend larger, the extent and severity of this damage will also increase.

c) Impacts on other users;<sup>10,11,12</sup> Large wakes traveling across open water can impact the user experience as it creates choppiness and disturbance on the surface. This effect is exacerbated where there are hardened shorelines, such as on Canyon Lake, as wave energy is deflected and reverberated rather than absorbed. Current research also shows that wakes from wake boats will travel over 500' before attenuation occurs, which is significantly farther than wakes from other boats.

2. Larger and heavier boats create stronger prop wash;<sup>12,13,14</sup> Current research shows the prop wash emanating from propellers of motorized watercraft can reach depths of 10' or more. This can lead to the disturbance of lakebed sediments, subsequently increasing turbidity and nutrient loads within the water column. Strong prop wash can also damage aquatic plants that otherwise help attenuate wave action and provide habitat. As wake boats trend heavier, and more power is needed to push the boat through the water, the depth of influence and potential for negative effects of prop wash will also increase. Imposing a boat weight limit now may help mitigate some of these negative effects and avoid future damage.
3. Wake boats will only continue to grow larger and heavier; Nearly all of the current research surrounding the effects of wake boat wakes and prop wash has been conducted with boats weighing 5,000 pounds or less, while some boats under 21.5' on the market are nearing 6,000 pounds (dry weight). Implementing a boat weight limit now could help prevent degradation of social, economic, and environmental resources as described above, and it would also help preserve the status quo on boating regulations that residents of Canyon Lake generally seem to favor. A dry boat weight limit of 5,000 pounds will also encompass nearly all boats currently in use on Canyon Lake, including wake boats.

## **Conclusion**

As previously noted, highly urban settings pose unique challenges in determining carrying capacity, as exceeding capacity may not necessarily result in typical indicators such as non-use, user dissatisfaction, or user conflict. These challenges were displayed in this study, where: (a) several respondents indicated they would still use the lake at the most crowded level seen in the simulated photographs (although they would likely not engage in towed watersports); (b) several other respondents reported that they enjoyed seeing the lake crowded because it meant people were recreating outside and having fun; and (c), in-person conversations with marine patrol revealed there is very little user conflict on the lake, even during over-crowded conditions. This left crowding metrics, rather than social indicators, as the predominant factor in determining carrying capacity on Canyon Lake.

The results of this study will likely not translate to other similar bodies of water, however, as aggregate densities of user ratios and social perceptions of crowding generally vary widely across geographies and cultures. In some areas, where user type is highly diverse, aggregate densities may not be an acceptable tool as they will not accurately reflect the needs and perceptions of each user group. Use patterns and social perceptions also change over time, meaning the results of this study will not be valid indefinitely. Consequently, long term monitoring, along with proactive management, will be necessary to maintain a favorable and enjoyable recreation experience on Canyon lake.



## Appendix A - Time-Lapse Photo Examples

Photo showing one motorized boat



Photo showing three motorized boats





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