

Attachment 1

Boating Carrying Capacity Review

April 3, 2012

1. INTRODUCTION

BACKGROUND

The purpose of this review is to provide background data to help determine an appropriate number of boat moorings at Pinecrest Lake. This issue arose during the development of the Pinecrest Lake Shoreline Management Plan (SMP). To determine how many mooring buoys would be appropriate at Pinecrest Lake, it was necessary to identify the potential carrying capacity of the reservoir. This review was developed to help identify reasonable carrying-capacity ranges for Pinecrest Lake.

For decades boaters have been able to moor their boats at Pinecrest Lake without regulation of any kind. Some boaters have moored their boats to mooring buoys/floats for short periods of time while visiting the lake, while others have taken advantage of the free and unregulated mooring and have left their boats in the lake all season. Currently there are no directives regarding where boats can be moored to buoys (other than within 200 feet of the dam), the size or type of vessel that can be moored, periods of time when they can be moored, or the type of mooring buoy/float or anchor (which range from cement blocks, to metal anchors, to cement-filled plastic antifreeze containers).

Pacific Gas and Electric (PG&E), the Stanislaus National Forest (STF), the Federal Energy Regulatory Commission (FERC), and other parties have identified unregulated mooring as an issue that needs to be addressed as part of the SMP. During an informal inventory conducted in June 2010, 195 buoys/floats were counted in the 300-acre reservoir, and 152 boats of varying sizes and types were moored to these buoys/floats. Because the increasing demand for water-based recreation in California is expected to continue, the demand for a resource like Pinecrest Lake likely will also increase. The current free and unregulated mooring buoy/float situation at Pinecrest Lake makes the reservoir even more attractive to boaters. In light of this trend, it is logical to conclude that the unregulated environment at Pinecrest Lake will attract more boaters, with a resulting increase in the number of unregulated buoys/floats.

REVIEW OF LITERATURE ON CARRYING CAPACITY

There are a number of studies, technical articles, and presentations available that discuss ways and approaches to determine the carrying capacity for recreational boats on lakes and reservoirs. Section 7, Bibliography, lists the studies, technical articles, and presentations that were examined for this review. One of the more useful documents was a handout prepared as part of a presentation given at the Changing Lakes, Changing Policy Workshop held in Pewaukee, Wisconsin, on February 13, 2010. The handout and presentation were prepared by Paul Dearlove of the Lake Ripley Management District in Wisconsin. As Dearlove noted, carrying capacity can be thought of as a threshold that, if exceeded, would lead to an undesirable set of conditions or problems.

Dearlove and others identified a number of factors that contribute to defining the carrying capacity at lakes and reservoirs. The following factors are of value for determining thresholds at Pinecrest Lake:

- **Lake use characteristics.** It is necessary to understand lake use patterns in terms of how the lake or reservoir is being used, who is using it, the types of boats used on the lake or reservoir, and the number and types of boats present on the water during peak and nonpeak times.
- **Usable lake surface area.** The amount of lake surface that can support boating activities is critical for establishing carrying-capacity thresholds and determining an appropriate mix of boating activities and boat types. This area is often calculated by subtracting a shoreline buffer zone of predetermined width from the total acreage of the lake. Buffer zones include areas along the edge of the lake that are too shallow or close to the shoreline for safe boating and lake areas that contain navigational hazards, such as marinas, piers, swim rafts, floats for public swimming beaches, moored boats, and underwater obstructions.
- **Boating density standards.** Boating density standards are usually represented in surface acres per type of watercraft or activity. Optimum densities depend on users' preferred setting types and site-specific attributes. Boating speed has a major influence on boating density. The faster a boat travels on a waterbody, the more acres per boat are needed to allow for safe maneuverability. Faster boating speed lowers the boating density of a lake or reservoir. The studies that were reviewed for this document report or suggest different densities for different types of vessels and activities. The specific densities mentioned in these studies often differ, but do provide ranges of densities to consider that will assist in establishing carrying-capacity thresholds at Pinecrest Lake and determining appropriate mixes of boating activities and types. The various densities described in the studies are identified in Section 4, Boating Density Standards.
- **Lake use rate.** Not all boats that are moored at a lake use it at the same time. The percentage of boats used at a lake during a certain time is called the "lake use rate." Knowing this rate is important for establishing carrying-capacity thresholds. The lake use rate can vary greatly by season, day of the week, and time of day. For assisting in establishing carrying capacity, lake use rates are usually estimated during times of maximum, or peak, use periods such as summer holiday weekends.

These four factors are used to organize the discussion regarding potential carrying capacity and appropriate number of potential mooring buoys at Pinecrest Lake; they are discussed in more detail below. It should be noted that in addition to the four factors identified above, other factors such as speed limits, water surface use and speed zones, directional use of a lake (for example, where all vessels are required to travel in a clockwise direction during periods of heavy use), and the presence of law enforcement also influence carrying capacity.

2. LAKE USE CHARACTERISTICS

OVERVIEW

Recreational use of lakes and reservoirs can vary widely depending upon a number of characteristics. Larger bodies of water typically offer a wider range of uses than smaller ones and often allow watercraft to travel at greater speeds. Boat speed, boating activities, and the types of

boats found at lakes can vary widely. Lake and shoreline uses that can influence limits on boating speed and the types of boating permitted include the following:

- The presence of ecologically sensitive areas where wildlife could be disturbed by noise and activity related to high-speed boats
- Areas where shoreline could be eroded due to wakes generated by boats
- The presence of residences whose occupants could be disturbed by noise generated by boat motors or boaters
- Other types of uses (i.e., swimming, fishing, marinas) and safety factors (i.e., shallow water, submerged hazards)

People who use lakes for recreation also have different characteristics and expectations that can influence carrying capacity. The type of activities people participate in, as well as the region in which they live and participate in recreation, can have a great deal of influence on recreational experience expectations. For example, people fishing in a remote section of a lake are likely to have different expectations and perceptions of crowding than groups of people socializing on multiple boats in a popular part of a lake. Likewise, recreationists spending several days boating on a large waterbody like Lake Oroville would have different expectations than people recreating for an afternoon on a small mountain lake. These perceptions might also be influenced by region (recreationists in areas with denser populations might accept more crowded conditions, as might people with fewer lakes to choose from), distance to population centers, historical recreational use patterns and other factors.

PINECREST LAKE USE CHARACTERISTICS

The recreation section of Exhibit E (Environmental Report) of the *Final Environmental Impact Statement (FEIS) for the Relicensing of the Spring Gap-Stanislaus Hydroelectric Project* (the “Project”) examined existing recreation characteristics and conditions at Pinecrest Lake (FERC, 2002). FERC reported that reservoir use was highest in the afternoon and peaked on weekends and holidays. The most frequently observed activities were motorized boating, sailboating, and paddle (nonmotorized, nonsailing) boating. The percentage of watercraft types observed were motorized boats (51.9 percent); motorized partyboats (7.2 percent); nonmotorized kayaks, canoes, and rowboats (16.9 percent); sailboats (7.9 percent); and paddleboats (16.1 percent). Some of the recreation data examined by FERC were collected in the early 2000s, and the number of nonmotorized boats, particularly kayaks, is believed to have increased significantly since then. Speed restrictions of 20 miles per hour (mph) on the reservoir do not allow high-speed boating activities, such as waterskiing, to occur. Tuolumne County does not allow personal watercraft (PWC) to operate on the reservoir.

The recreation studies that were conducted for the relicensing effort included fixed-wing flights over Pinecrest Lake on two Saturdays (June 30 and July 28, 2001) at approximately 9:00 a.m. and 1:30 p.m. The June 30 date was chosen to represent a holiday summer weekend (Fourth of July) and July 28 was chosen to represent a nonholiday summer weekend. During the June 30 morning aerial survey, 42 watercraft were counted as being active; 92 watercraft were spotted during the afternoon survey. During the July 28 survey 50 vessels were counted in the morning, and 75 in the afternoon.

During the summers of 2001 through 2007, the Tuolumne County Sheriff’s Department conducted counts of watercraft using Pinecrest Lake and being stored on its waters or along its

shoreline (R. Demartini, 2011). Between 2001 and 2003, only motorized boats were counted. The 2005 to 2007 counts included motorized boats and other types of watercraft (kayaks, canoes, paddleboards, paddleboats, tubes, etc.) being stored at Pinecrest Lake. The counts show a steady general increase in the number of watercraft at Pinecrest Lake. The number of watercraft counted was as follows:

- Motorized Boats Only
 - 2001 = 43
 - 2002 = 126
 - 2003 = 193
 - 2004 = 174
- Motorized and Other Watercraft
 - 2005 = 281
 - 2006 = 302
 - 2007 = 610

Pinecrest Lake has been an important recreation resource for multiple generations of recreationists. One of the most noteworthy, historical, and visible activities at the reservoir has been sailing small sailboats. Various groups of sailors have sailed at Pinecrest Lake for over 50 years and have historically launched their small sailboats from a beach at the southeastern part of the reservoir. In recent years, these sailors have typically set up approximately six mooring buoys near this beach from the last week of June through just before Labor Day (J. Haire, 2012). The sailboats are moored to the buoys for the day and/or overnight. Most of the small sailboats are El Toros (generally 8 feet or less in length) and Lasers (generally less than 14 feet in length).

3. USABLE LAKE SURFACE

OVERVIEW

Evaluating usable lake or reservoir surfaces often considers shoreline buffer zones or buffers near shoreline areas, as well as objects in the water (and safety buffers around them) that would limit or restrict certain types of boating activity. The intent of buffers is to generally identify areas where high-speed boating or certain types of boating would not be appropriate due to safety or environmental factors. Establishing buffers removes these areas from the total amount of usable lake surface. The buffer distances identified in the reviewed literature are provided in the bulleted list below; these examples are generally for larger lakes, and it should also be noted that these buffers are likely not directly applicable to Pinecrest Lake due to the existing speed limits (20 mph) on the lake that would somewhat negate their utility:

- 100 feet from the shoreline at a large lake in Maryland on which a variety of water-based activities occur (Bosley, 2005)
- 200 feet from the shoreline and 400 feet from marinas and swimming beaches at large lakes with power boats traveling at high speeds (Jaakson et al., 1990)
- 200 feet from the shoreline at Lake Ripley, a 418-acre lake in rural Wisconsin (Lake Ripley Management District, 2003)

Other objects within a lake or reservoir, such as docks, buoys, stumps, rocks, aquatic vegetation, swimming platforms, and dams, are also considered (and in some cases assigned a buffer) when

determining usable surface area. The degree to which these objects could reduce usable surface area is determined by the speed and type of boats using the lake, the types of activities that occur, and the size of the lake. Greater distances would be required for objects in reservoirs where higher speed limits are allowed versus reservoirs where there are lower maximum speed limits. Likewise, lakes where high-speed activities such as waterskiing occur would require greater buffers than lakes where slower and less active activities occur.

PINECREST LAKE USABLE LAKE SURFACE FINDINGS AND ASSUMPTIONS

The amount of usable surface area at a lake or reservoir is determined by a number of factors, as described previously. One of the factors that can vary over time at water storage reservoirs such as Pinecrest Lake is the amount of surface area available for recreation. The amount of water stored in reservoirs and surface area often fluctuates during the year and can influence usable lake surface. The elevation of Pinecrest Lake ranges from a maximum of 5,620 feet above sea level at full pool (300 surface acres) down to the Project's winter pool elevation of 5,585 feet above sea level. The reservoir is kept as full as possible during the summer recreation months consistent with operational demands and current license conditions. It typically fluctuates between 5,615 (289 surface acres) and 5,610 (269 surface acres) between Memorial Day and Labor Day.

Full pool at Pinecrest is considered to be elevation 5,620 feet above sea level. At this elevation, Pinecrest Lake has 300 acres of surface area. PG&E attempts to maintain an elevation of 5,618 feet from Memorial Day through the Labor Day weekend (the main recreation season for which carrying capacity is being estimated). At an elevation of 5,618, Pinecrest Lake has a surface area of approximately 295 acres.

The U.S. Forest Service (USFS) conducted a boating and fishing recreation study at Pinecrest Lake in 1964 (USFS, 1964) and stated that the lake had 275 usable acres of surface water when full. The study did not identify what objects (shoreline buffers or other features) were subtracted from the total surface area to determine usable acres. Objects at Pinecrest Lake that could be considered in determining usable surface area include marina facilities (docks and safety log-boom), fire boat dock, permittee docks, dam, intake structure, swimming beach, fishing platform, and unregulated moored boats.

The recreation section of the FEIS (see Exhibit E, page E7-47; FERC, 2002) for the relicensing of the Project assumed that all 300 acres were usable, but provided a caveat that the "estimate may be slightly high considering the high level of swimming activity, docks in several locations and round the reservoir shoreline, shallow water depth (particularly near the marina), and the low level of boating regulation enforcement." Considering the presence of the swimming area, the marina, 39 permittee docks, the public boat-launch ramp, the fireboat dock, the fishing platform, the PG&E intake structure, the dam, and numerous unregulated moored boats and buoys/floats, less than 300 acres of the reservoir surface is usable. The recreation section of Exhibit E did not mention the number of unregulated moored boats at Pinecrest Lake. An informal count on July 7, 2010, found 195 unregulated buoys/floats of varying types in the reservoir, of which 152 had watercraft of varying types and sizes moored to them (M. Greenig, 2010). This number of moored boats would reduce the usable surface area of Pinecrest Lake.

The USFS study and the recreation section estimates contained in Exhibit E of the FEIS (FERC, 2002) did not consider boating speed as a factor that would reduce the amount of usable surface area at Pinecrest Lake. Although the speed limit at Pinecrest Lake is 20 mph, boaters cannot operate their boats at that speed throughout the entire the reservoir. Section 655.2 (Speed Limit

for Vessels in Certain Areas) of the California Harbors and Navigation Code 2012 states that motorized boats may not exceed 5 mph in areas that are within 100 feet of people swimming and 200 feet of beaches frequented by bathers, swimming floats delineating swimming areas, and docks or floats to which boats are moored (California Boating and Waterways Commission, no date). At Pinecrest Lake the 200-foot distance would include the swimming beach, the commercial marina (and breakwater), seasonal residential cabin permittee docks, and boats moored to buoys.

The Tuolumne County ordinance code (Section 8.24.065 [Boating] of Chapter 8.24) contains distance requirements for boating that are similar to State of California requirements. The Tuolumne County ordinance code also states that it is unlawful to operate a boat within 200 feet of a dam. When these factors are considered (and an assumption that boats cannot travel faster than 5 mph when within 100 feet of the shoreline), the amount of usable lake surface at Pinecrest Lake is reduced further.

An estimate of usable lake surface area was developed for a pool elevation of 5,618 feet. A buffer of 200 feet was placed around the swim beach, the marina, permittee docks, and the dam. Unregulated boats moored to buoys were not considered. A buffer of 100 feet was placed around shoreline areas not covered by the 200-foot buffer. With those assumptions in place, the usable lake surface area for boats traveling between between 5 and 20 mph was estimated to be 235 acres.

4. BOATING DENSITY STANDARDS

OVERVIEW

The literature that was reviewed relative to boating density presented a variety of different boating density standards. It can be assumed that the density standards for motorized boats in the list of reviewed literature below would be greater than what would be appropriate for Pinecrest Lake because it is very likely that those lakes do not have a lakewide, 20-mph maximum speed limit like Pinecrest Lake does. Most of the lakes and reservoirs that were examined are larger than Pinecrest Lake's 300 acres. A variety of boating standards were reported in the literature. Among the standards that were reported are the examples below:

- Jaakson et al. (1989)
 - Waterskiing and motorboat cruising: 20 acres per boat
 - Boat fishing: 10 acres per boat
 - Canoeing, kayaking, sailing: 8 acres per boat
 - Note that the lakes examined were between 1,750 and 2,400 acres in size
- Warren and Rea (1989)
 - Motorboats: 9.0 acres per boat
 - Fishing from boat: 1.3 acres per boat
 - Sailboats: 4.3 acres per boat
 - Canoes and kayaks: 1.3 acres per boat
 - Waterskiing boats : 12.0 acres per boat

- Florida Department of Environmental Protection, Division of Recreation and Parks (2005)
 - Limited power (10 horsepower [hp] or less) boating: 5 to 10 acres per boat (recommends a waterbody with a minimum of 200 acres for activities using less than 10 hp)
 - Unlimited power boating: 10 to 20 acres per boat (recommends a waterbody with a minimum of 600 acres for activities using boats with unlimited power)
 - Water skiing: 20 to 50 acres per boat (same as unlimited power boating)
 - Sailing: 20 to 50 acres per boat (recommends a waterbody with a minimum of 200 acres)
 - No power, still water: 5 to 10 acres per boat (recommends a waterbody with a minimum of 50 acres)
- New York State Office of Parks and Recreation (Bosley, 2005)
 - Sailboat: 6 to 8 acres per boat
 - Powerboats: 6 to 8 acres per boat
 - Waterskiing: 15 to 20 acres per boat
 - Fishing anchored: 0.3 to 0.5 acre per boat
 - Rowboats: 1 acre per boat
 - Fishing trolling: 1 acre per boat
 - Canoes and kayaks: 1 acre per boat

ASSUMPTIONS FOR PINECREST LAKE

In the recreation section of Exhibit E of the FEIS (FERC, 2002) for the relicensing of the Project, FERC concluded that approximately 60 percent of the boats at Pinecrest Lake were motorized and 40 percent were nonmotorized. During an SMP stakeholder meeting, most boats on the reservoir were reported to be less than 18 feet in length, which means that most boats using Pinecrest Lake are relatively small boats compared with many larger lakes and reservoirs in northern California. This information was used to develop the proposed boating density standards for Pinecrest Lake. Based upon the small size (300 acres) of Pinecrest Lake, the relatively slow speed limit (20 mph), the fairly small size of most boats, and the low-key types of boating use on the lake (fishing, sightseeing, sailing, paddling, and similar), denser boating standards were determined to be appropriate at Pinecrest Lake compared with other larger, bodies of water.

5. LAKE USE RATE

OVERVIEW

Not all boats that are moored on a waterbody are active at the same time. The lake use rate is the percentage of boats moored at a lake that actively use it at the same time. Two literature sources that were reviewed discussed lake use rate (EDAW, 2004; Bosley, 2005). EDAW, Inc. (2004) conducted recreation studies for the California Department of Water for the FERC relicensing of the Oroville facilities (which include Lake Oroville) in northern California. Although Lake Oroville is much larger than the Pinecrest Lake (15,500 acres vs. 300 acres), it, too, receives peak recreational use over the major summer holidays (Memorial Day, Fourth of July, and Labor Day). During the relicensing studies, FERC estimated that, on average, during all summer weekends in which counts were conducted, 56 percent of all boats on the lake (active, stored, or moored) were active (moving). During the three busiest weekends, 40 percent were active on the reservoir and 60 percent were beached or moored.

The Bosley (2005) study included findings on lake use rates. Bosley reported that another study of a lake in Michigan containing shoreline residences estimated the peak lake use rate was 10 percent of boats moored at existing shoreline developments; however, Bosley suggested 15 percent might be a more realistic percentage for the percentage of boats used by adjacent shoreline residents. Bosley also reported that the study estimated that the peak lake use rate for boats launched from public facilities was 50 percent of the capacity of the public facilities during peak times.

ASSUMPTIONS FOR PINECREST LAKE

Based upon discussions with STF staff and the Pinecrest Lake Resort (PLR), the weeks between early July and mid-August and over the Labor Day weekend are the busiest at Pinecrest Lake. Although use is high throughout the week, it can be even greater on weekends. Peak use at Pinecrest Lake is assumed to occur during these times. The PLR also indicates (based on rental data) that the highest peak use period is during the afternoons of the busiest summer weekends and that, other than those afternoons, they generally have plenty of rental boats that are available. This suggests that maximum peak use periods at Pinecrest Lake are somewhat limited.

To determine the lake use rate at Pinecrest Lake during these peak periods, the percentage of varying types of boaters that use the lake must be estimated. Based in part on the studies discussed by Bosley for reservoirs in North Carolina (that have lakeside residences with docks and receive use by people launching boats from ramps), it can be assumed that the lake use rate of permittees with docks would be lower than lake use rates of boaters launching boats from public facilities or the PLR Marina. Bosley estimated 10 to 15 percent of the boats moored at private docks next to residences would be actively boating on a lake during peak periods. Because many permittees can only access their cabins by water, it is assumed that a greater lake use rate for permittees (20 percent) occurs at Pinecrest Lake during peak use periods than occurs at the lakes and reservoirs in North Carolina that Bosley discussed.

Most of the boaters using Pinecrest Lake during peak periods do so from boats moored at or rented from the PLR Marina, launch their boats from the public boat launch (and park their trailers at trailer parking spaces), launch their human- or wind-powered boats from various shoreline locations, launch from seasonal residential permittee docks, or launch from the many unregulated buoys/floats. Based on the reported lake use rates cited previously, 40 to 50 percent of the boats moored at the marina and 40 to 50 percent of the boats launched from the public boat launch ramp (and whose trailers are parked in the trailer parking areas) are estimated and assumed to be on the water during peak use periods. The boats that are moored to the unauthorized buoys/floats are not considered in this discussion. These estimates were confirmed after reviewing rental data at the PLR for popular summer weekends in 2011 (PLR, 2012).

As noted previously, the recreation study that was conducted for the relicensing effort found that during a weekend in 2001 near the Fourth of July counted 92 vessels active on Pinecrest Lake during an afternoon flyover. A nonsummer weekend afternoon flight in July 28 of 2001 found 75 boats active boats.

6. CARRYING CAPACITY

PREVIOUS CARRYING-CAPACITY ESTIMATES AT PINECREST LAKE

The 1964 USFS document described previously estimated that with a usable lake surface area of 275 acres, the carrying capacity of Pinecrest Lake would be 92 boats (based upon a mixture of motor and sailboats) at a boating density of three boats per acre (USFS, 1964). It went on to state

that based on USFS experience at Pinecrest Lake, when adequate law enforcement had been provided by Tuolumne County, a carrying capacity of up to 200 boats had been considered acceptable and safe. The document did not identify what adequate law enforcement entailed.

The recreation section of the FEIS (see Exhibit E, page E7-47; FERC, 2002) for the relicensing of the Project included a carrying-capacity estimate for the surface of Pinecrest Lake. Based upon an assumed usable lake surface area of 300 acres and a boating mix of 60 percent motorized and 40 percent nonmotorized boats, the carrying capacity for Pinecrest Lake was estimated to be 134 boats. The authors mentioned that the estimate might be slightly high considering the high level of swimming activity, docks in several locations around the reservoir shoreline, shallow water depth in areas, and the low level of boating regulation enforcement. They went on to state that, based upon their observations, it appeared that as of 2000, Pinecrest Lake was generally below this carrying-capacity number.

EXAMINING CARRYING-CAPACITY OPTIONS AT PINECREST LAKE

Two additional options for estimating carrying-capacity ranges were developed for this review and are displayed in Tables 1 and 2. Both options assumed that Pinecrest Lake has 235 acres of usable lake surface (at an elevation of 5,018 feet) for vessels going faster than 5 mph. Both options assumed that there would be no unregulated boats moored on the reservoir and that the same percentage of boating types that have historically used the reservoir would continue to use it. These percentages were based upon percentages identified in the Recreation Resources section of Exhibit E of the *Final License Application for the Spring Gap-Stanislaus Project* (FERC, 2002). The two options used different boating density standards, as explained below.

Option 1

Option 1 assumed boating-density standards that were similar to the standards identified in the literature reviewed and described previously. This option used the “low” end of the spectrum of the various standards (which would allow for higher boating densities resulting in fewer acres per boat) for several reasons, the first being size. With a maximum acreage of 300 acres, Pinecrest Lake is smaller than most reservoirs and lakes to which the literature pertained. As a result, many water-oriented activities that require more space per boat (like waterskiing and high-speed boating) for safety do not occur at Pinecrest Lake, or do so in limited numbers. In addition, the speed restriction of 20 mph at Pinecrest Lake discourages many types of boating activities that involve high speeds that would necessitate more space per boat. These slower speeds justify the assumption that fewer acres per motorized boat at Pinecrest Lake compared to most larger lakes are appropriate.

As seen in Table 1, using the historical percentage of boats types that have used Pinecrest Lake and some of the “denser” boating densities (which allow fewer acres per boat) that were described in the literature, the total carrying capacity would be 76 boats.

Table 1. Option 1: Carrying Capacity of Pinecrest Lake

Type of Boat	Use at Pinecrest Lake (percentage)	Boating Density Used (acre per boat)	Number of Boats That Could Be on Lake by Percentage of Use That Would Meet Boating Density Standards
Motorized boats	52	4.3	39
Motorized party	7	4.3	5
Human-powered	33	1.3	25
Sailboats	8	1.3	7
Total	100		76

Option 2

The only difference in the assumptions made for Option 2 and those made for Option 1 is that Option 2 would change the boating density to allow even greater density for motorized boats and party boats than was allowed in Option 1. Slightly lowering the acres per motorized boat and party boat from 4.3 acres per boat to 3.5 acres per boat would increase the carrying capacity from 76 to 89 boats.

Table 2. Option 2: Carrying Capacity of Pinecrest Lake

Type of Boat	Use at Pinecrest Lake (percentage)	Boating Density Used (acres per boat)	Number of Boats That Could Be on Lake by Percentage of Use That Would Meet Boating Density Standards
Motorized boats	52	3.5	46
Motorized party	8	3.5	7
Human-powered	32	1.3	29
Sailboats	8	1.3	7
Total	100		89

Table 3 compares the carrying-capacity estimates from the four estimates described above. As can be seen in Table 3, carrying-capacity numbers range from a high of 134 to a low of 76. A reasonable range of boats to consider for the carrying capacity of Pinecrest Lake is between approximately 76 and 89 boats.

Table 3. Comparison of Carrying-Capacity Estimates

Carrying-Capacity Versions	Boat Types (percentage)	Assumed Usable Lake Surface (acres)	Carrying Capacity
Option 1	Motorized boats: 52 Motorized party: 7 Human-powered: 33 Sailboats: 8	235	76
Option 2 (denser standards than Option 1)	Same as Option 1	235	90
Recreation Resource Study (from Final License Application)	Motorized: 60 Nonmotorized: 40	300	134
1964 STF Report	Did no categorize	275	89 ¹
Note 1: The 1964 STF Report stated that up to 200 boats were considered acceptable and safe when adequate law enforcement had been provided by Tuolumne County.			

DETERMINING THE NUMBER OF POTENTIAL MOORING BUOYS AT PINECREST LAKE

To determine if mooring buoys would be appropriate at Pinecrest Lake, the carrying capacity of Pinecrest Lake needed to be compared with likely boating use rates to determine if mooring buoys would contribute to exceeding carrying capacity. To make this determination, the following sequence of factors was considered:

1. Identify the number of boats that are currently authorized to moor at Pinecrest Lake (at the PLR and at permittee docks); this estimate excludes the boats moored around the lake at unauthorized mooring buoys.
2. Add the number of trailer spaces near Pinecrest Lake to establish the approximate number of boats that could launch into Pinecrest Lake from the public ramp, and add that number to the total from Step 1 to determine the number of vessels that could potentially use Pinecrest Lake (this does not take into account vessels that could be hand-launched from the shoreline).
3. Estimate the level (percentage) of use of the authorized boats during peak use periods to determine how many of them would be estimated to be using the reservoir during peak use periods; note that this level (percentage) varies by boating type.
4. Multiply Step 3 (level or percentage of use) percentages by Steps 1 and 2 to determine the number of nonmotorized hand-launched boats that could be expected to use Pinecrest Lake during peak periods; note that this number might be less or greater than the carrying capacity.
5. Determine how many nonmotorized (human- and wind-powered) boats would be expected to be on the reservoir during periods of peak use. The highest aerial count made from the recreation study found 92 vessels. The recreation study determined that 40 percent of the boats that use the reservoir are nonmotorized, so it can be reasonable to assume that half (47) of the 92 vessels counted would be nonmotorized. Some number of these nonmotorized boats are moored at either permittee docks, the PLR marina, or launched at the boat ramp and their

trailers parked at one of the trailer parking stalls; the remainder is assumed to be hand-launched from other locations. If half of the human-powered vessels (47) are assumed to be hand-launched, then 24 additional human-powered boats could be assumed to be on the reservoir during peak periods.

6. To determine how many buoys might be appropriate, the number from Step 4 (likely number of vessels at peak periods) is subtracted from the carrying capacity. If the number from Step 4 is greater than the carrying capacity, then there would be no room for buoys.

Using these steps outlined above, the following was calculated.

1. It is estimated that 339 boats are currently authorized to moor at Pinecrest Lake. These vessels are moored at the following areas:
 - PLR = 261 boats (200 permanent seasonal slips and 61 boats temporary slips at elevation 5,612 feet)
 - Seasonal residence permittee docks = 78 (assumes 2 boats per each of the 39 permitted docks)
 - $261 + 78 = 339$
2. There are spaces for approximately 33 boat trailers to park.
3. It is estimated that 40 percent of the boats that are authorized to moor at PLR would be actively boating (not tied up to docks or the shoreline) on the reservoir during peak use periods. Also, 20 percent of the permittee boats are estimated to be actively boating on the reservoir during peak use periods. These percentages are similar to those in the literature that was reviewed. During peak use periods, all 33 boat trailer spaces are estimated to be filled, and most (75 percent) of these boats would be actively boating on the reservoir.
 - PLR boats (261) x 40 percent = 104 boats
 - Permittee boats (78) x 20 percent = 16 boats
 - Boats launched from ramp with trailers parked in parking spaces (33) x 75 percent = 25 boats
 - Hand-launched nonmotorized boats = 24
 - Total = **169 boats could be reasonably expected to be actively using the reservoir during the highest part of peak use periods**

The approximately 170 boats that could reasonably be expected to be actively using Pinecrest Lake during the highest part of the peak use period (afternoons of major summer holiday weekends) would exceed the carrying capacity range of between 76 and 89 boats discussed previously. The carrying-capacity range at Pinecrest Lake likely occurs several times during the summer season. It can be assumed that the carrying-capacity range at Pinecrest Lake will be exceeded more frequently over time as recreational demand for boating continues to increase on a state-wide, regional, and local basis.

POTENTIAL MOORING BUOYS AT PINECREST LAKE

Viewed strictly through the lens of the carrying-capacity range of Pinecrest Lake, removing all of the unauthorized mooring buoys/floats and the watercraft that moor to them would seem to be a logical way to address current and future issues associated with peak use period over capacity issues. However, PG&E and the STF realize that small boats, particularly small sailboats, have been a part of the historic fabric of Pinecrest Lake for decades and are closely integrated into its

history. Input from stakeholders made it very clear that sailboats in particular are a valued part of Pinecrest Lake and that small boats have been mooring in the southeast part of the lake for decades. PG&E and the STF acknowledge this historic use and believe that allowing a reduced number of sailing and other small boats to moor to buoys in the southeast part of the lake would support this historic use, support the Forest Plan directive related to mooring small boats at Pinecrest Lake, and respond to stakeholder desires without greatly contributing to exceeding carrying capacity. Because small sailing and human-power boats are slower than motorized boats, they require less space (see Tables 1 and 2) than other types of boats, thus their contribution to exceeding carrying capacity would be less than other types of watercraft. In addition, by concentrating mooring to one area, less of the lake would be affected by moored boats than is currently the case.

The Draft SMP proposes using the area in the southeast part of the lake where sailboats have traditionally moored because the area has advantageous wind patterns, good access from roads, nearby parking, and hand-launch facilities. The proposed area for the moored boats is within the middle of the Shoreline Boating Access Use Area (see Exhibit 1 of the Draft Pinecrest Lake Shoreline Management Plan). This location allows for unencumbered watercraft access into Pinecrest Lake within this area, on either side of the area where boats would be moored. Assuming that all boats would be 18 feet in length (many would be less) and would have a 23-foot swing radius, at least 20 boats would be able to moor within this area. Therefore, for the purposes of the initial estimate of the number of mooring buoys that would be appropriate at Pinecrest Lake, 20 mooring buoys are proposed. As described in the Mooring Buoy Program section of the Draft SMP, this number may well be fine-tuned upwards or downwards depending upon factors such as the sizes of boats that drawing winners have, the level of interest in the drawing, and other factors that may change over time.

7. BIBLIOGRAPHY

- Bosley, Holly E. 2005. *Techniques for Estimating Boating Carrying Capacity: A Literature Review Prepared for: Catawba-Wataree Relicensing Coalition*. North Carolina State University, Department of Parks, Recreation & Tourism Management. Raleigh, North Carolina. August 2005.
- Dearlove, Paul. 2010. *Changing Lakes, Changing Policy Workshop*. Handout and presentation prepared by Paul Dearlove of the Lake Ripley Management District, Wisconsin. February 13, 2010.
- Demartini, Roland. 2011. E-mail from Sgt. Roland Demartini/Tuolumne County Sheriff's Department to Mark Greenig/CH2M HILL. October 14, 2011.
- California Boating and Waterways Commission. 2012. *California Boating Law: Laws and Regulations Concerning Recreational Boating, Including Public Access, Safety and Education, Marine Law Enforcement, and Consumer and Environmental Protection*. <http://www.dbw.ca.gov/PDF/LawEnforc/2012CBL.pdf>. Current as of January 1, 2012. Accessed February 12, 2012.
- EDAW, Inc. 2004. *Reservoir boating, Final R-7, Oroville Facilities Relicensing FERC Project No. 2100*. The State of California, Department of Water Resources. March 2004.

- Federal Energy Regulatory Commission (FERC). 2002. *Final Environmental Impact Statement for Stanislaus River Projects: Spring Gap-Stanislaus Hydroelectric Project—FERC Project No. 2130, Beardsley/Donnells Hydroelectric Project—FERC Project No. 2005, Donnells-Curtis Transmission Line Project—FERC Project No. 2118, Tulloch Hydroelectric Project—FERC Project No. 2067*. Volume I, Exhibit E, Section 7, Recreation Resources. Federal Energy Regulatory Commission.
- Florida Department of Environmental Protection, Division of Recreation and Parks. 2012. *Visitor Carrying Capacity Guidelines*.
<http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf>.
 Accessed January 12, 2012.
- Greenig, Mark. 2010. Count conducted by Mark Greenig/CH2M HILL and Patti Kroen/Kroen Consulting. July 7, 2010.
- Haire, James. 2012. E-mail from James Haire, Pinecrest Lake El Toro sailor to Mark Greenig/CH2M HILL. February, 10, 2012.
- Jaakson, R., M.D. Buszynski, and D. Botting. 1989. "Carrying capacity and lake recreation planning (Part I)." *The Michigan Riparian*, pp. 11-12, 14. http://mi-riparian.org/archive/feb_1989.pdf. November 1989.
- Jaakson, R., M.D. Buszynski, and D. Botting. 1990. "Carrying capacity and lake recreation planning (Part II)." *The Michigan Riparian*, pp. 7-8. http://mi-riparian.org/archive/1990/feb_1990.pdf. February.
- Lake Ripley Management District. 2003. *Lake Ripley Watercraft Census and Recreational Carrying Capacity Analysis*. Cambridge, Wisconsin. December 2003.
- Pinecrest Lake Resort (PLR). 2012. E-mail from Heidi Lupo/Pinecrest Lake Resort to Mark Greenig/CH2M HILL. February, 29, 2012.
- Tuolumne County. 2012. *Tuolumne County Ordinance Code*. Available at http://portal.co.tuolumne.ca.us/psp/ps/TUP_COUNTY_COUNSEL/ENTP/s/WEBLIB_PTPP_SC.HOMEPAGE.FieldFormula.IScript_AppHP?scname=ADMN_TUOLUMNE_COUNTY_ORDINANCE&FolderPath=PORTAL_ROOT_OBJECT.ADMN_SC_SP_TUOLUMNE_COUNTY_ORD.
- U.S. Forest Service (USFS). 1964. Internal letter regarding Pinecrest fishing and boating pressure. March 6, 1964.
- Warren, R., and P. Rea. 1989. *Management of Aquatic Recreation Resources*. Publishing Horizons, Inc. Columbus, Ohio.