State of California
The Resources Agency
Department of Water Resources

RESERVOIR BOATING

FINAL

R-7

Oroville Facilities Relicensing
FERC Project No. 2100

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Oroville Facilities Relicensing
FERC Project No. 2100

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REPORT SUMMARY

This document presents the results of R-7 – *Reservoir Boating*, one of several recreation studies conducted to support Oroville Facilities Relicensing (Federal Energy Regulatory Commission [FERC] Project No. 2100). The California Department of Water Resources (DWR) commissioned this study as part of the relicensing process for the preparation of a license application to be submitted to FERC for the Oroville Facilities. As part of the relicensing process, a series of related studies are being conducted to assess and evaluate recreation resources associated with the Oroville Facilities. This report presents the results of one of those studies: an analysis of reservoir boating within the study area.

INTRODUCTION

This study report is divided into seven sections. Section 1.0 (Introduction) provides background information about the Oroville Facilities. Section 2.0 (Need for the Study) addresses why the study is necessary to support relicensing. Section 3.0 (Study Objective) addresses the purpose of the study. Section 4.0 (Methodology) discusses how the data and information used in this study were obtained. Section 5.0 (Study Results and Analysis) presents the results of this study. Section 6.0 (Discussion and Conclusions) brings together key results and provides conclusions about reservoir boating in the Project Area drawn from those results.

Lake Oroville is the second largest reservoir in California, after Shasta Lake, with over 15,000 surface acres at full pool. The Oroville Facilities include three other smaller reservoirs downstream of Lake Oroville: the 320-acre Diversion Pool, the 630-acre Thermalito Forebay, and the 4,300-acre Thermalito Afterbay. The Oroville Facilities were developed as part of the State Water Project (SWP), a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in Northern California, the San Francisco Bay area, the San Joaquin Valley, and Southern California.

The Oroville Facilities support a wide variety of recreational opportunities. They include boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating campsites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment.

NEED FOR THIS STUDY

This study is needed to comply with FERC regulations requiring preparation of a comprehensive recreation plan and, more specifically, requiring information in the license application regarding existing and future recreational boating use at Project facilities and waters (Chapter 1, Subpart F, Section 4.51 of 18 CFR). In addition, the study is needed to assess the impact of Project operations and reservoir management on recreational reservoir boating. Reservoir boating is a major recreation activity in the study area and is

directly affected by project operations, particularly reservoir pool levels. Study R-3 – *Assessment of the Relationship of Project Operations and Recreation* provides a more in-depth discussion of this topic. River boating is discussed in Study R-16 – *Whitewater and River Boating*.

STUDY OBJECTIVES

The main objectives of this study are to describe existing recreational boating infrastructure, boating use, boaters' perception of conditions, and water surface management on Lake Oroville and the other reservoirs within the study area. Study results are used to determine the existing condition of boating facilities, existing use levels for reservoir boating, and whether existing facilities are adequate given the amount and character of boating use. Additionally, the results will help determine if capacity limits for boating are being exceeded on the reservoirs, and if reservoir surface water management changes are needed relative to recreational boating.

METHODOLOGY

Information on the features and condition of existing Project Area boating facilities was obtained through direct on-site observations, primarily conducted for Study R-10 – *Recreation Facility and Condition Inventory*. Boat ramp facilities were evaluated using standards developed by national and state boating organizations.

Information on boating management issues and problems were gathered through interviews with personnel from DWR, California Department of Parks and Recreation (DPR), and California Department of Fish and Game (DFG) and with representatives of law enforcement agencies with responsibilities in the Project Area. Statewide data related to boating accidents were compiled from California Department of Boating and Waterways (DBW) boating safety reports; Project-specific data were compiled from DWR incident reports and the DBW reports. These data were primarily compiled for Study R-2 – *Recreation Safety Assessment*.

Data on boating use at the Project reservoirs were obtained through direct observations of boat traffic conducted between May 2002 and August 2003. Observations were conducted on Lake Oroville from research boats traveling through designated zones, generally during the mid-afternoon peak-use time. Similar observations were conducted on the other Project reservoirs from land-based vantage points. Observers mapped the location and type of all boats present, including boats in use but beached or moored near shore. A total of 37 observations were conducted on all zones of Lake Oroville, and a similar number were conducted at the downstream reservoirs.

Data on the characteristics of boaters and boater groups and on boaters' perceptions of conditions at the reservoirs were obtained through On-Site and Mail-Back Surveys conducted from May 2002 to May 2003. Over 2,500 visitors were contacted at Project Area recreation sites, more than half of whom boated during their visit to the Oroville area. Over 1,100 Mail-Back Surveys were returned. Additional information for

comparison purposes was obtained through surveys conducted over one or two weekends at each of three other reservoirs in Northern California.

Surface water boating capacity was assessed by reviewing data from the recreation facility inventory, boat counts and other observations, visitor surveys, and inventories of sensitive wildlife and vegetation. The analysis addresses four type of capacity: facility, physical/spatial, social, and ecological. Based on the combined data on the four capacity types, current or likely future limiting factors are identified for each of six Lake Oroville zones and the downstream reservoirs.

STUDY RESULTS

The typically large annual fluctuation of Lake Oroville presents a significant challenge in providing for boating use. At the start of the study period in May 2002, the pool elevation was about 837 feet. About six months later, the pool elevation had decreased 147 feet to 690 feet, the lowest level during the 15-month study period. The pool elevation rose quickly over the following 6 months, reaching its high near 900 feet (full pool) in early June 2003, an increase of 210 feet. The typical drawdown over the summer peak boating season is 50–75 feet. Pool elevation changes on the three Project reservoirs downstream of Lake Oroville are relatively minor, although daily changes at Thermalito Afterbay occasionally have some effects on boating.

Boating Infrastructure and Effects of Reservoir Drawdown

The boat ramps and associated facilities on Lake Oroville and the downstream reservoirs were in good condition and generally meet nationally accepted and applied standards for the design of such facilities. Two boat ramps (Bidwell Canyon and Loafer Creek) do not meet standards for provision of designated single-vehicle parking spaces, and related car parking limitations have occasionally led to turn-away at Bidwell Canyon. All but two (Loafer Creek and Enterprise) of the five developed ramps meet standards for low-water usability as measured by the percent of days during peak boating season (from Memorial Day weekend to Labor Day weekend) that the ramps were useable. The other three existing ramps were extended by DWR in December 2002 and will provide boaters year-round access in most years.

In addition to aforementioned effects on boat ramps, seasonal drawdown of Lake Oroville reduces the usable boating area and may increase boating hazards associated with exposed land and standing timber in some areas. Major underwater hazards are marked by buoys maintained by DPR. Prominent signage at boat ramps warns boaters about lake level changes and submerged obstacles and warns boaters to watch for unmarked hazards.

Boating Safety and Other Key Issues

State and local law enforcement and resource agency personnel described several boating issues as being of special concern. These include boaters not wearing personal

flotation devices (PFDs), unsafe use of personal watercraft (PWC), and alcohol use by boaters, among other concerns. Boaters' responses to surveys provided information on their level of concern about boater safety, water level, and boating facility issues.

Boating accident data for 1997–2002 indicated that reported accidents and injuries have been infrequent in recent years. Two accidents were reported at Lake Oroville and one at Thermalito Afterbay during 2002. One fatality occurred on Lake Oroville in 1999, and one fatality occurred on Thermalito Afterbay in 2001.

Boating Use Levels

Peak season boating use on Lake Oroville was highest on holiday weekends, when from 700 to over 1,000 boats were observed in use on the lake. Half or more of these boats were beached or moored on or near shore in popular sheltered coves where houseboaters and others congregate. Peak season non-holiday weekend use was approximately 300 to 650 boats, while weekday use was 150 to 225 boats. Overall, about half of the boats observed were runabouts/ski boats, 20 percent were houseboats, and about 10 percent were PWC. The remaining 18–20 percent consisted of pontoon boats, fishing boats, sailboats, and others. The Middle Fork and South Fork zones of the lake received the most use.

Boating activity during the non-peak season was much lower than the peak season, with 50–150 boats counted on weekends and 50–100 boats counted on weekdays. About three-fourths of boats on the lake during the non-peak season were fishing boats.

Boating use was very low on Thermalito Diversion Pool and Thermalito Forebay throughout the study period. Use of Thermalito Afterbay was low in most areas, but was moderately high during the peak season in areas closest to the two boat ramps, where PWCs launch and congregate.

Boater Characteristics and Perceptions

The survey data provided a wide range of information on boaters and boater group characteristics. For example, most boaters were in groups of three or more, they were about evenly split between Butte County and non-Butte County residents, and a high percentage visited the Oroville area three or more times per year.

Boaters' perceptions of other boaters' behavior and of water conditions were particularly notable. About 10 percent said they had experienced boating behavior that put them at risk, and about 14 percent said they had observed such behavior putting others at risk. A wide range of behaviors was described, such as unsafe use of PWC and other boats coming too close or not yielding right-of-way. About 15–20 percent of boaters described moderate or big problems during their visit, including the number of other boats on the lake; boat speed, noise, and wakes; and encounters with PWC. Concern was much more widespread regarding some aspects of water conditions, with 48 to 55 percent of boaters indicating that they considered water level fluctuation, exposed land, and shallow areas

due to low water to be moderate or big problems during their visit. These results probably reflect the low water conditions present by mid-summer of the 2002 peak season.

Regarding the adequacy of boating facilities, just over half of all boaters surveyed felt the number of temporary moorings or docks were too few (several of the major boat ramps have only a single boarding dock). From 35 to 44 percent felt there was a need for more boat-in campsites, places to get gas, boat ramps, and marinas, while from 55 to 65 percent felt the number of these facilities was "about right."

Boating Capacity

Several indicators were used to assess facility capacity at Lake Oroville, including boat ramp parking space occupancy, launch wait time, and perceived need for more ramps. Parking capacity was exceeded during the peak season at Bidwell Canyon Marina and, less often, at Lime Saddle Marina due to a large portion of vehicle-trailer spaces being used by single vehicles. At both sites, parking for visitors to the adjacent marinas appears inadequate for the level of use at the marinas. From 33 to 55 percent of boaters said they typically had to wait to launch at each primary ramp, and wait times were reported to average 9 to 11 minutes. A minority reported having to wait 20 minutes or more. Only at Bidwell Canyon Marina did a majority of boaters feel there was a need for additional boat ramps.

Assessment of social capacity for Lake Oroville relied primarily on survey data related to boaters' perceptions of crowding on the water and encounters with other boaters. Overall, perceptions of crowding were low, and relatively few boaters considered the amount of boat traffic or interactions with other boaters to be a problem. However, high percentages of boaters using the Middle Fork and South Fork zones on peak season weekends and holidays felt those areas were at least moderately crowded. This suggests those zones may be approaching social capacity limits at those times.

Physical or spatial capacity was assessed by comparing the amount of space available to each boat observed during the boat counts to a set of proposed standards for boat traffic density. Boat traffic allowing 10 or fewer acres per boat was considered to be exceeding physical capacity. Average boat traffic density was found to be low to moderate on all Lake Oroville zones during peak season non-holiday weekends, even if beached or moored boats were included. Density was very low on the downstream reservoirs. Results were similar for peak season holiday weekends, with the exception that average traffic density was high on the Middle Fork zone if beached and moored boats were included in the calculation. If only active boats are included, average boat traffic density was moderate.

Ecological capacity was assessed by reviewing results of Study R-11– *Recreation and Public Use Impact Assessment* and focused on shoreline erosion and identification of sensitive shoreline vegetation. Additional sources included the Study T-9 – *Recreation and Wildlife* (Interim Report) and preliminary results from Study W-3 – *Recreational*

Facilities and Operations Effects on Water Quality. Although some shoreline erosion was noted at Lake Oroville boat-in campsites, few areas with lasting impacts were identified. Steep and rocky shorelines minimize boater use in many areas around Lake Oroville. Few areas of sensitive shoreline vegetation occur around Lake Oroville, but such areas are more widespread around Thermalito Forebay and Afterbay. The likelihood of disturbance of bald eagle nesting territories was judged to be low based on restrictions placed on human activity and the low amount of boating activity in those areas.

For each zone of Lake Oroville and on the downstream reservoirs, capacity information was used to identify factors that either currently limit use or that will likely limit acceptable use levels in the future. Given current boating use, none of the Lake Oroville zones or downstream reservoirs was considered to be exceeding capacity. Boating use of the West Branch and Upper North Fork zones of Lake Oroville was judged to be approaching capacity limits, largely based on limitations on boat launching in the zones. Boating use of the Lower North Fork and Main Basin zones was judged to be below capacity limits, with the expectation that social capacity limits would be the most likely limit reached should use increase significantly in the future. Boating use of the Middle Fork and South Fork zones were judged to be approaching capacity limits, primarily based on the amount of water area available for active boats and the amount of shoreline suitable for houseboats and others to congregate in the zones. Visitor concerns about crowding at peak use times were also a factor for the South Fork zone.

All three downstream reservoirs were judged to be below capacity limits. Given the unique non-motorized and nature-focused boating experience offered by the Diversion Pool, social capacity was judged to be the most likely future limiting factor if use increases. On Thermalito Forebay and Afterbay, the wildlife resources characterizing many shoreline areas and the importance of those reservoirs for waterfowl indicate that ecological factors are the most likely future limiting factor.

CONCLUSIONS

Overall, the Oroville Facilities are providing safe and enjoyable recreation opportunities and experiences for a wide variety of boaters. Most facilities are in good condition and adequately meet boater access needs, although some limitations related to parking have been identified at certain sites. While access at low water levels is good at most sites, boaters in the Enterprise area and visitors to the Loafer Creek area may have to launch elsewhere during some seasons due to low water. Safety issues related to unsafe boater behavior and physical water hazards appear to be limited in scope, but require continued attention and vigilance on the parts of managing agencies and law enforcement.

There are presently few issues of concern regarding boating use levels on the Project reservoirs. Even considering the highest use during peak season holiday weekends, active boat traffic levels are moderate or low in most areas. The high number of boats spending all or part of the recreation day beached or moored on or near shore reduces boat traffic issues. Given that use of the Middle and South Fork zones may be

approaching physical and social capacity limits at peak use times, any actions that might increase boating activity or density in those areas should receive careful consideration in regards to possible capacity effects.

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ACRONYMS AND ABBREVIATIONS

af	acre-feet
ATV	all-terrain vehicle
BIC	boat-in campsite
BLM	U.S. Bureau of Land Management
BR	boat ramp
Caltrans	California Department of Transportation
cfs	cubic feet per second
DBW	California Department of Boating and Waterways
DFG	California Department of Fish and Game
DPR	California Department of Parks and Recreation
DUA	day use area
DWR	California Department of Water Resources
FERC	Federal Energy Regulatory Commission
FRSA	Feather River Service Area
LOSRA	Lake Oroville State Recreation Area
maf	million acre-feet
mph	miles per hour
msl	mean sea level
MW	megawatt
NOAA	National Oceanic and Atmospheric Administration
OWA	Oroville Wildlife Area
PFD	personal flotation device
PG&E	Pacific Gas and Electric
PWC	personal water craft
RD	recreation day
RV	recreational vehicle
RVD	recreation visitor day
SR	State Route
SRA	State Recreation Area
SVRA	State Vehicular Recreation Area
SWP	State Water Project
USACE	U.S. Army Corps of Engineers
USBR	U.S. Department of the Interior Bureau of Reclamation

1.0 INTRODUCTION

This document presents the results of Study R-7 – *Reservoir Boating*, one of several recreation-related studies conducted for the Oroville Facilities (FERC Project No. 2100) relicensing. This study presents a quantitative and qualitative assessment of reservoir boating safety, boating infrastructure, boating use levels, boaters' perceptions, and boating capacity within the study area and develops issues to be considered during the relicensing process.

This report is divided into seven sections. The first (Section 1.0 Introduction) provides background information about the Oroville Facilities. The second section (2.0 Need for Study) addresses why the study is necessary to complete the relicensing. The third section (3.0 Study Objective) addresses the purpose of the study. The fourth section (4.0 Methodology) discusses how the data and information used in this study were obtained. The fifth section (5.0 Study Results and Analysis) develops and puts into context the results of this study. The sixth section (6.0 Discussion and Conclusions) brings together key results and provides conclusions about reservoir boating in the Project Area drawn from those results. The final section (7.0 References) lists the sources used to complete this study.

1.1 BACKGROUND INFORMATION

The California Department of Water Resources (DWR) commissioned this study as part of the relicensing process for the preparation of a license application to be submitted to the Federal Energy Regulatory Commission (FERC) for the Oroville Facilities. As part of this relicensing process, related studies are being conducted to assess and evaluate recreation resources associated with the Oroville Facilities. This report presents the results of one of those studies: an evaluation of reservoir boating in the study area including at Lake Oroville, Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay.

Lake Oroville is the second largest reservoir in California, after Shasta Lake. Existing facilities at Lake Oroville offer a wide variety of recreational opportunities. These include numerous facilities for visitors to boat, fish, and camp. Opportunities to camp in the area include fully developed, primitive, boat-in, and floating campsites. Boating facilities include two full-service marinas, five developed boat ramps, five car-top boat ramps, ten floating campsites, and seven floating toilets located around Lake Oroville. There are major developed recreation facilities at Loafer Creek, Bidwell Canyon, Spillway, and Lime Saddle. Additional recreational and visitor facilities are located at Thermalito Diversion Pool, Thermalito Forebay, Thermalito Afterbay, and the Oroville Wildlife Area (OWA). The locations of recreation facilities at each of these areas are depicted in Figure 1.1-1.

Other recreation opportunities include picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife viewing, and hunting. The area also offers a visitors

center and other visitor information sites with cultural and informational displays about Project facilities and the area's natural and cultural environment.

1.2 STUDY AREA

The study area includes all lands and waters inside and within one-fourth mile of the FERC Project boundary, and adjacent lands, facilities, and areas with a clear project nexus. The study area extends from south of the city of Oroville to reaches of the South Fork, Middle Fork, and North Fork of the Feather River (Figure 1.1-1). Within the study area are Lake Oroville, Thermalito Forebay, Thermalito Afterbay, Thermalito Diversion Pool, and the OWA. Lake Oroville, Thermalito Diversion Pool, and Thermalito Forebay are within the Lake Oroville State Recreation Area (LOSRA) which is managed by the California Department of Parks and Recreation (DPR). Project facilities such as the Oroville Dam, Hyatt Powerplant, Thermalito Diversion Dam and Powerplant, Thermalito Power Canal, and the Thermalito Pumping-Generating Plant, are excluded from this analysis as the public is not generally allowed to visit these types of Project facilities.

1.3 DESCRIPTION OF FACILITIES

The Oroville Facilities are located on the Feather River at the foothills of the Sierra Nevada in Butte County, California. The Oroville Facilities were developed as part of the State Water Project (SWP), a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in Northern California, the San Francisco Bay area, the San Joaquin Valley, and Southern California. The Oroville Facilities are also operated for flood control power generation, to improve water quality in the Sacramento–San Joaquin Delta (Delta), enhance fish and wildlife, and provide recreation.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, the OWA, Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, transmission lines, and a relatively large number of recreational facilities. An overview of these facilities is provided in Figure 1.3-1. Oroville Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-foot (maf) capacity storage reservoir with a surface area of 15,810 acres at its maximum normal operating level of 900 feet above mean sea level (msl).

Figure 1.1-1. Project Area and related recreation sites.

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[backside of Figure 1.1-1]

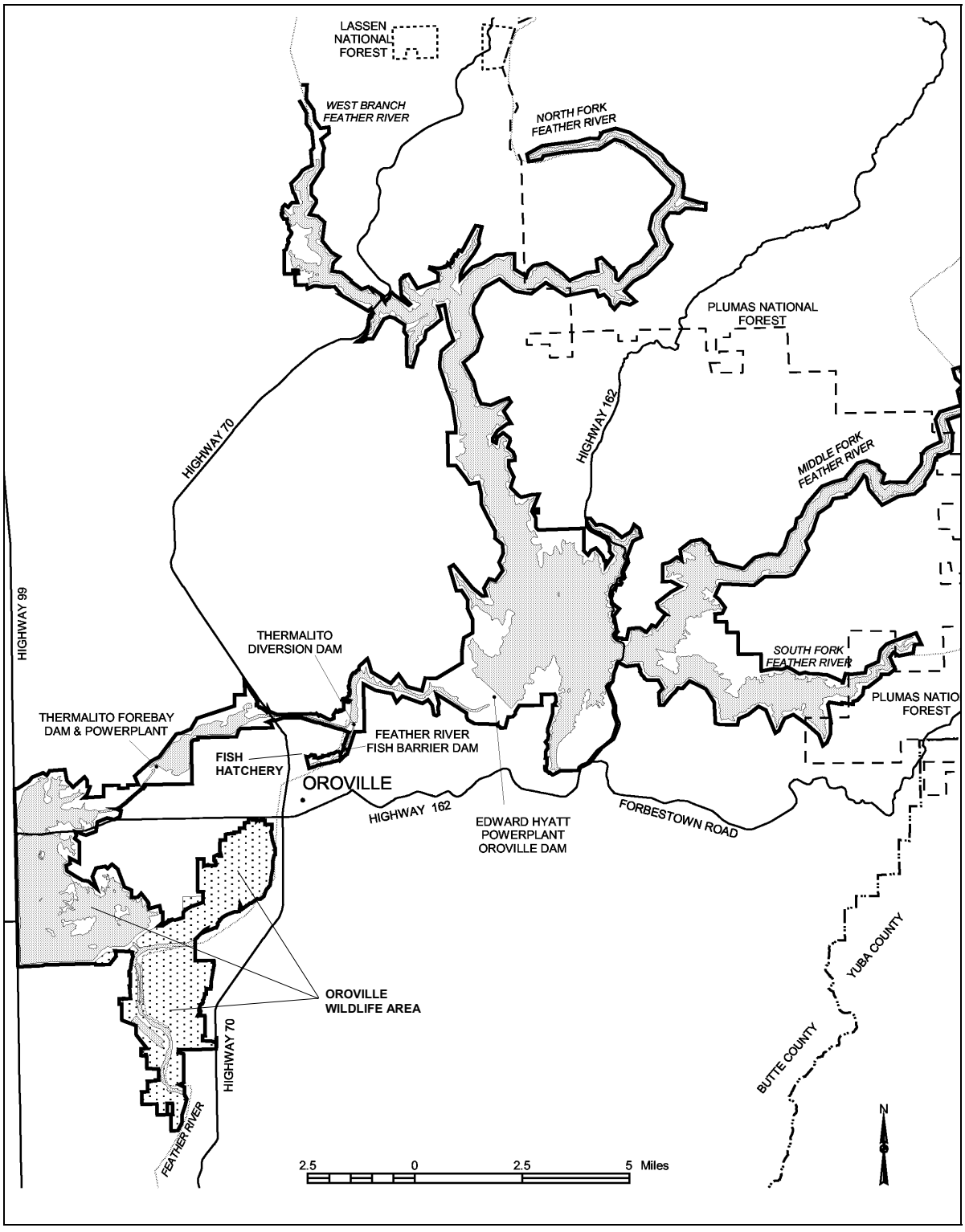

Figure 1.3-1. Oroville Facilities and the FERC Project Boundary.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts (MW). The Hyatt Pumping-Generating Plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 and 5,610 cubic feet per second (cfs), respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam, 4 miles downstream of Oroville Dam, creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water into the Thermalito Power Canal. Thermalito Diversion Dam Power Plant is located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cfs of water into the river.

The power canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. Thermalito Forebay is an offstream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into Thermalito Afterbay, which is contained by a 42,000-foot-long earthfill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, provides recreational opportunities, and provides local irrigation water. Several local irrigation districts receive Lake Oroville water via Thermalito Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Thermalito Afterbay outlet, and provides attraction flow for the hatchery. The hatchery is an anadromous fish hatchery intended to compensate for salmon and steelhead spawning grounds made unreachable by construction of Oroville Dam. Hatchery facilities have a production capacity of 10 million fall-run salmon, 5 million spring-run salmon, and 450,000 steelhead annually (pers. comm., Kastner 2003). However, diseases have reduced hatchery production in some recent years.

The Oroville Facilities support a wide variety of recreational opportunities. They include boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural

environment. As described in Section 1.1, there are major recreation facilities at Lake Oroville and additional recreation facilities in the OWA, Thermalito Afterbay, and along the low-flow channel of the Feather River.

The OWA comprises approximately 11,000 acres southwest of Oroville that is managed for wildlife habitat and recreational activities. It includes Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the Feather River. The 5,000-acre area is adjacent to or straddles 12 miles of the Feather River, and includes willow and cottonwood–lined ponds, islands, and channels. Recreational opportunities include dispersed recreation (hunting, fishing, and bird watching); recreational activities also take place at developed sites (the Monument Hill Day Use Area [DUA], model airplane grounds, and three boat launches on Thermalito Afterbay and two on the river) and at some primitive camping areas. DFG's habitat enhancement program has included a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a few locations.

1.4 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly, and hourly, depending on hydrology and the objectives DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, diversion, and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for Project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning is conducted for multi-year carryover storage. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1.0 maf; however, this does not limit drawdown of the reservoir below that level. If hydrology is drier or requirements are greater than expected, additional water could be released from Lake Oroville. The operations plan is updated regularly to reflect forecast changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum operating level of 900 feet above msl in June and then lowered as necessary to meet downstream requirements, to a minimum level in December or January (approximately 700 msl). During drier years, the reservoir may be drawn down more and may not fill to desired levels the following spring. Project operations are directly constrained by downstream operational demands and flood management criteria as described below.

1.4.1 Downstream Operation

An August 1983 agreement between DWR and DFG, entitled "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife" (DWR and DFG 1983) sets criteria and objectives for flow and temperatures in the low-flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona that vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period (except for flood management, failures, etc.); (3) requires flow stability during the peak of the fall-run Chinook salmon spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.4.1.1 In-Stream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that the Oroville Facilities release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the in-stream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 acre-feet (af) (i.e., the 1911–1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become dewatered.

1.4.1.2 Temperature Requirements

Thermalito Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery temperature objectives are 52°F for September, 51°F for October and November, 55°F for December through March, 51°F for April through May 15, 55°F for the last half of May, 56°F for June 1–15, 60°F for June 16 through August 15, and 58°F for August 16–31. In April through November, a temperature range of plus or minus 4°F is allowed for objectives.

There are several temperature objectives for the Feather River downstream of the Thermalito Afterbay outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook salmon. From May through August, the temperatures must be suitable for shad, striped bass, and other warmwater fish.

The National Oceanic and Atmospheric Administration (NOAA) Fisheries has also established an explicit criterion for steelhead trout and spring-run Chinook salmon, memorialized in a biological opinion on the effects of the Central Valley Project and the SWP on Central Valley spring-run Chinook and steelhead. As a reasonable and prudent measure, DWR attempts to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure attempts to maintain water temperatures at less than or equal to 65°F on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California Independent System Operator (ISO) anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR provides water for the Feather River Service Area (FRSA) contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., minimum 65°F from approximately April through mid-May, and minimum 59°F during the remainder of the growing season), although there is no explicit obligation for DWR to meet the rice water temperature goals. However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractors' temperature goals.

1.4.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 af (July 2002) are made from the Thermalito Complex during the May through August irrigation season. The total annual entitlement of the Butte and Sutter County agricultural users is approximately 1.0 maf. After meeting these local demands, flows into the lower Feather River (and outside of the Project 2100 Boundary) continue into the Sacramento River and into the Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay, where the water is stored until it is pumped into the California Aqueduct.

1.4.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest reasonable water quality, considering all demands being made on Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.4.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with USACE.

The flood control requirements are an example of multiple use of reservoir space. When flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable storage limit (the point at which specific flood releases would have to be made) varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle floodflows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry. When the wetness index is high in the basin (i.e., high potential runoff from the watershed above Lake Oroville), required flood management space is at its greatest to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR THIS STUDY

This study is needed to meet the Federal Energy Regulatory Commission's (FERC) direction regarding preparation of comprehensive recreation plans, and more specifically to include information in the license application regarding existing and future recreational boating use at Project facilities and waters (Chapter 1, Subpart F, Section 4.51 of 18 CFR). In addition, the study is needed to assess the impact of Project operations and reservoir management on recreational reservoir boating and boating safety. Reservoir boating is a major recreation activity in the Study Area and is directly affected by project operations, particularly reservoir pool levels. Study R-2 – *Recreation Safety Assessment* provides more comprehensive information and discussion on recreation safety in the Project area. Similarly, Study R-3 – *Assessment of the Relationship of Project Operations and Recreation* provides more comprehensive information and discussion of project operation effects on recreation. River boating is discussed in Study R-16 – *Whitewater and River Boating*.

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3.0 STUDY OBJECTIVE

The main objective of this study is to describe existing recreational boating use and water surface management on Lake Oroville and other reservoirs where boating is permitted within the study area. The study addresses Issue Statement R1–adequacy of recreation facilities. Several dozen more specific recreation issues related to reservoir boating as identified by local stakeholders are also addressed, as identified in the Study Plan (DWR 2002). Study results are used to determine existing use levels for reservoir boating, and to help determine if reservoir surface water or recreation management changes are needed relative to recreational boating.

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4.0 METHODOLOGY

4.1 RESEARCH ON LOCAL BOATING ISSUES

Local boating issues were researched through documented sources such as boating accident statistics, boating law enforcement agency interviews, boater surveys, and boating regulations and management.

To identify issues related to boating safety and law enforcement in the study area, representatives of the following agencies responsible for recreational boating safety in the study area were interviewed: DPR, DFG, DWR, and Butte County Sheriff's Office. These managers and law enforcement officers have unique insights into boating safety and related issues in the study area. California Highway Patrol (CHP) staff deferred to DWR staff for comments on boating safety-related issues. These interviews were conducted as a part of Study R-2 – *Recreation Safety Assessment*.

Boating accident statistics were acquired from DBW. DBW collects information only on those accidents where there was a fatality, or an injury that requires medical attention beyond first aid, or property damage greater than $500. Due to a variety of reasons, not all of these accidents are reported to DBW. Data were also obtained from the 2001 and 2002 *California Boating Safety Reports* (DBW 2002, 2003). These reports provided insight into Statewide boating issues, primarily as a basis for comparison to Project Area issues. Locations of boating accidents on Project Area reservoirs were acquired from DPR and are reported in Study R-2 – *Recreation Safety Assessment*.

The effects of reservoir pool elevation changes on boating were also evaluated. Much of this analysis was completed as a part of R-3 – *Assessment of Relationship of Project Operations and Recreation*. This portion of the study included field work to assess the condition and usability of boating facilities at different pool elevations. Water hazards at various pool levels were observed during field work as discussed below.

4.2 ASSESS RESERVOIR BOATING USE LEVELS

One task of the *Reservoir Boating* Study was to document the amount and character of boating activity on the four reservoirs in the study area—Lake Oroville, Thermalito Forebay, Thermalito Afterbay, and Thermalito Diversion Pool. This documentation has been accomplished through a series of field observations (from which counts were derived) conducted from a boat, from shore vantage points, and using aerial photography.

4.2.1 Lake Oroville On-Water Boating Activity Observation Methods

On Lake Oroville, observations were conducted from a boat moving through six designated zones on the reservoir (Figure 4.2-1). One researcher drove the survey boat while another recorded observations with assistance from the driver in heavily used areas. Binoculars were used when necessary to find and categorize distant boats.

Figure 4.2-1. Lake Oroville area reservoir boat count zones.

[insert 8x11]

The observers marked the location and type of each watercraft observed in use on zone maps. Six boat-type categories were used: runabouts/ski boats, jet skis, houseboats, fishing boats, pontoon boats, and sail and other non-motorized boats. Letters were used to indicate boat types (e.g., R = runabout, F = fishing boat, H = Houseboat). Boats in the process of being launched or retrieved at boat ramps and boats moored or docked at the two marinas were not counted.

Several areas of the lake are popular places for boats (particularly houseboats) to beach or tie up to trees on shore. These "in use but inactive" boats (including all those beached, moored, or anchored on or near shore) were also observed and marked on the maps. These boats may remain beached or moored at a single location for periods ranging from a few hours to several days. These boats were differentiated from active boats because they were essentially "parked" at the time they were observed and were not contributing to boat traffic at that time. This distinction is important when analyzing the effect of boat traffic on crowding and reservoir carrying capacity.

The survey boat proceeded through the zones as quickly as possible while still allowing the observer to note all active and beached/moored boats and to mark their location and type on a map of the zone. Passing through an area quickly reduced the chance that the same boats would be counted twice. On some observation days, choppy water or high amounts of floating debris reduced the speed at which the count could safely be conducted. To the extent possible, observers made note of boats that were following the same general route as the observation boat to avoid counting them a second time.

It is logistically very difficult to obtain a "snapshot" or instantaneous measurement of the amount and distribution of boating activity on a reservoir the size of Lake Oroville. The objective was, instead, to complete observations across the entire lake in a period of time short enough to reasonably represent peak use (within 2 to 3 hours). Most observations were conducted between 2 and 5 p.m. to capture peak use for the respective day.

Because it was not possible for a single boat to conduct observations on the entire reservoir in that period of time, each survey boat was usually assigned to cover only two or three of the six zones, with two or three boats used to cover all six zones. Each zone took from 30 minutes to 1.5 hours to complete, depending on such factors as the size of the zone, the extent of no-wake and low-speed areas, and amount of boat traffic present.

During peak use season weekends, two boats usually conducted the observations together on the three busiest zones that comprise the southern half of the lake, while one boat covered the three less-busy zones that comprise the northern half. One of the two boats working as a team focused on counting in deep coves and in areas with high numbers of beached and moored boats, while the other focused on more open areas of the zones and on active boats. The two boats stayed close to each other as they conducted the observations to minimize double counting of boats. The intent of using

teams of two boats in these areas was to shorten the time required to complete the counts and to maximize the accuracy and completeness of the observations.

4.2.2 Thermalito Diversion Pool, Forebay, and Afterbay Observation Methods

Observations were also conducted at the Forebay, Afterbay, and Diversion Pool on most of the Lake Oroville observation dates, although these areas were assigned lower priority if there were staffing limitations. The observations on these three areas were conducted by a single observer from vantage points on bridges crossing the reservoirs and from shoreline locations. As on Lake Oroville, binoculars were used when necessary to find and categorize distant boats. The observer also counted boat trailers at access points to supplement or corroborate the boat observations.

4.2.3 Derivation of Boat Counts and Boat Traffic Densities

Tallies of the boats of each type observed were taken from the marked maps used to record the field observations. Separate tallies were made for active boats and beached or moored boats. The results section of this report provides these tallies for each observation date and observation zone. The counts of individual boats are also summarized as average number of boats-at-one-time (BAOT) on the water surface of each zone, and average number of the different boat types.

The boating capacity results rely on calculation of boat traffic density (acres of reservoir surface area per boat). These values were calculated for each observation after determining the approximate pool elevation and corresponding surface area of each observation zone on the day of the observation.

4.2.4 Aerial Photography Boat Observation Method

Aerial photography was also used to obtain counts of boats on the reservoirs. The purpose of these counts was to provide data to validate boating use levels obtained with the on-water observations. On-water observations were conducted on all six Lake Oroville zones at approximately the same time as the aerial photography, using four or five boats and eight to ten drivers and observers. Observations at the other reservoirs used the same land-based observations method as used on non-aerial-photo observation dates.

The aerial photographs were taken from a fixed-wing aircraft flying a pre-determined route over the reservoirs at an elevation of about 1,000 feet above the water. The route provided close to 100 percent coverage of the reservoirs in the photographs taken. The flights were conducted Sunday, May 25, 2003 (Memorial Day weekend), and Saturday, June 28, 2003, between about 4 and 6 p.m. One hundred five 9-by-9-inch photographs were provided from each flight. The detailed images had a scale of 1:9,000 (1 inch = about 750 feet), which allowed a count of boats to be derived from the photographs using a10X magnifier. It was not possible to determine boat types from the aerial photographs. The photographs did not cover the Diversion Pool.

4.2.5 On-Water Boat Observation Sampling Schedule

The boating use observations were conducted over a 16-month period between Memorial Day weekend of 2002 and late August 2003 (Table 4.2-1). Although the Study Plan called for observations to be concluded in April 2003, the observations were extended into the summer. This was due to logistical problems and low-water conditions on Lake Oroville during the summer and fall of 2002 that prevented the original schedule from being completed. Lake Oroville pool levels during the fall of 2002 were the lowest they had been in 10 years. Use of boat launch facilities was severely limited, and most ramps were closed by mid-September. The prevalence of shallows and underwater obstructions also made boating more difficult. Therefore, subsequent boating use observations were postponed until late January 2003 in order to conduct the observations under more typical boating conditions.

A total of 40 observations were conducted on the reservoirs. Twenty-four of the observations were conducted during the 2002 and 2003 peak seasons (from Memorial Day to Labor Day Weekend). Five of the peak season observations were holiday counts, conducted on Memorial Day, Independence Day, and Labor Day weekends. Sixteen observations were conducted during the non-peak season (before Memorial Day Weekend and after Labor Day Weekend).

Table 4.2-1. Sampling frequency for boating use observations at the Oroville Facilities, 2002–03.

Count Season / Type	Dates / Time Period	No. of Sampling Dates[a]
Peak Season Counts (24 total)		
Peak Season Holiday	Memorial Day Weekend, Independence Day Weekend[b], Labor Day Weekend	5
Peak Season Weekend	Weekends between Memorial Day Weekend and Labor Day Weekend (not including Independence Day weekend)	13
Peak Season Weekday	Weekdays between Memorial Day weekend and Labor Day weekend	6
Non-Peak Season Counts (16 total)		
Non-peak Season Weekend	Weekends after Labor Day weekend and before Memorial Day weekend	10
Non-peak Season Weekday	Weekdays after Labor Day weekend and before Memorial Day weekend	6
Total		**40**

a. Each sampling date tallied refers to one Project-wide sample, and includes observations conducted on a single day as well as those conducted over two or three consecutive days.
b. In 2002, Independence Day Weekend included Thursday, July 4 through Sunday, July 7. In 2003, Independence Day Weekend included Friday, July 4 through Sunday, July 6.
Source: EDAW 2003a.

Eighteen of the 40 observations covered all 6 segments of the reservoir in a single day. Most of the remaining observations were conducted over two consecutive days. The greater effort and staffing required to conduct observations on all zones in a single day

was focused on peak-season weekends and holidays, when peak boating activity occurs. Observations were conducted on less than all six Lake Oroville zones on about one-fourth of the observation dates due to bad weather (fog or rain storms), high amounts of floating debris, mechanical trouble with a boat, or insufficient staff. In most cases, the zones for which observations were not completed were on the upper half of the lake, where boat traffic is typically lower.

4.2.6 Assessment of Accuracy of On-Water Boat Observations and Counts

There are limitations on how completely and accurately boat traffic can be observed using the on-water methods described above. This method was chosen based on considerations of practicality, cost, and the opportunity it provided to observe the distribution and the character of boat traffic. The alternative method of counting vacant boat slips, moorings, and boat trailers is logistically burdensome and does not provide use distribution or boat type information. Aerial photography does not allow boat types to be identified, is considerably more expensive than land or water-based methods, and is more dependent on good weather (i.e., no rain or low cloud cover).

The boat counts obtained do not represent a “snapshot” of use, since boats would have entered and left the observation zones during the hour or more that the observation was in progress. The counts are likely to be most accurate for areas of the lake beyond the two-mile-wide Main Basin, where boats are more easily seen. Locations and times with the lightest use are also likely to produce the most accurate counts. High amounts of moving boat traffic in some areas presented difficulty for observers and could have increased the chance for error. Also, boats already counted may have overtaken the research boat and been mistakenly re-counted. Boats not yet counted in a zone may have been missed if they entered an area already covered while the research boat was occupied in an adjacent cove. Some boats may have also been missed during the counts due to heavy traffic or boats being hidden from view at the back of coves or behind other moored boats. These errors may offset each other to some extent. Overall, this methodology is estimated to provide an expected error of less than 10 percent.

4.3 ASSESS RESERVOIR BOATING INFRASTRUCTURE

This section describes reservoir boating-related facilities in the study area and the methods used to assess their functionality and adequacy. The types of reservoir boating facilities assessed in this study include boat ramps (trailer and car-top), boat-in-campsites, floating campsites, floating restrooms, and marinas. The locations of the facilities discussed are shown in Figure 4.3-1.

Figure 4.3-1. Project study area boating facilities.

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4.3.1 Lake Oroville Boating Facilities

There are four large boat ramps which provide access to the reservoir at high, moderate, and low pool levels including Bidwell Canyon Boat Ramp (BR) and Loafer Creek BR (both located at the south end of the main basin), Spillway BR (located near the northwest end of Oroville Dam) and Lime Saddle BR (located on the West Branch of the reservoir). These facilities provide access to the water during most of the year, except for occasional periods of very low water later in some years. All have large paved parking areas with space for several hundred vehicles and boat trailers. Enterprise BR, located on the South Fork arm of the Lake, is a smaller ramp that receives moderate use.

There are also five car-top boat ramps on the reservoir that provide access to hand-launched boats such as canoes and kayaks and, to a lesser and unofficial extent, small trailer-launched boats. Generally, these sites consist of old road beds that terminate in the lake. They typically receive moderate to low recreation use, depending on the pool elevation. Three of these facilities (Nelson Bar Car-top BR, Dark Canyon Car-top BR, and Vinton Gulch Car-top BR) are located on the West Branch arm of the reservoir. Foreman Creek Car-top BR is located on north end of the main basin, and Stringtown Car-top BR is located on the south side of the South Fork arm.

Several boat-in campsites located throughout the central portion of the reservoir provide traditional camping opportunities for boaters in the study area. These include Goat Ranch Boat-in Campground (BIC) and Bloomer Primitive BIC (located on the northern portion of the reservoir), Foreman Creek BIC (on the Main Basin), and Craig Saddle BIC (located where the Middle and South Forks converge). Ten floating campsites consisting of 20-by-24 foot two-story structures, with room for up to 15 people, are distributed in various coves in the southern half of the reservoir. Recreation use and facility capacity are summarized for BICs and floating campsites. Data for this portion of the report were obtained from DPR.

4.3.2 Diversion Pool, Thermalito Forebay, and Thermalito Afterbay Boating Facilities

The Diversion Pool Day Use Area (DUA) provides informal access to the water, primarily for small non-motorized watercraft. Boaters generally hand-launch canoes and kayaks from Burma Road, where it passes close to the shoreline about one-half mile upstream of the Diversion Dam. Small hand-launched fishing boats with electric motors are also allowed and occasionally used in the Diversion Pool.

Thermalito Forebay has three two- and three-lane boat ramps with floating docks at both the North and South Thermalito Forebay DUAs. These facilities provide access for trailer and car-top boats, with moderate-sized parking areas. Only non-motorized boats are permitted on the North Forebay.

Thermalito Afterbay has two paved primary boat ramps with floating docks, one unimproved car-top boat ramp, and a few undeveloped launch sites, all along the

eastern shore of the reservoir. The two improved boat ramps are Wilbur Road BR and Monument Hill BR. Monument Hill BR is within a day use facility with a small sand beach and restrooms and receives moderate to heavy recreation use. Larkin Road Car-top BR is an unimproved ramp with a vault toilet located on the southern portion of the reservoir. Occasional launching, mostly of sailboards, occurs at undeveloped sites located along Highway 162 across from Monument Hill BR on the north side of the highway.

4.3.3 Methods for Assessment of Boating Facilities

Some of the data for the assessment of boating facilities were collected as part of Study R-10 – *Recreation Facility and Condition Inventory* and Study R-3 – *Assessment of the Relationship of Project Operations and Recreation*. Additional field observations were made of certain boat ramp facility features for this study.

The *Recreation Facility and Condition Inventory* involved a review of documents related to Oroville Project facilities, interviews with personnel from key study area agencies, and field observations to directly assess conditions. Infrastructure deficiencies were noted and summarized. Specific features of boat ramps and associated facilities, such as ramp width and slope and vehicle-trailer parking, were evaluated using standards and guidelines developed primarily by the States Organization for Boating Access during the 1990s and recently published by the Ohio Department of Natural Resources (Ohio DNR 2003).

The *Assessment of the Relationship of Project Operations and Recreation* included an assessment of the usability of boat ramps and other boating-related facilities on Lake Oroville at moderate and low pool levels. The DWR Oroville Field Division provided minimum operating elevations for each Lake Oroville boat ramp, information which is also provided to the public on the agency's Lake Oroville Recreation Website. Periods of time when the pool level has been below these elevations are described herein for each Lake Oroville facility. Boat ramps at the other Project reservoirs are not greatly affected by reservoir level changes.

4.4 RESERVOIR BOATER SURVEYS

Study R-13 – *Recreation Surveys* provided additional information in the form of survey responses from boaters and other study area visitors. Recreation visitors in the Project Area were surveyed between May 2002 and May 2003 to ascertain their use of the area, their perceptions of the quality of recreation opportunities, and changes they believe would improve their recreation use. The survey methodology included a survey administered on-site and a follow-up mail survey (the Mail-Back Survey) sent to On-Site Survey respondents who provided a name and address. A portion of the On-Site Survey contained questions directed only to those who were boating during their visit.

This "boaters only" section of the On-Site Survey (Appendix A) contained questions relating to the boaters' current visit including areas boated, perceptions of crowding and unsafe boater behavior, and overall satisfaction with their boating experience. More

general questions asked about the boat they usually use at the lake, the boat ramps they use, and if they typically have to wait to launch their boat.

The Mail-Back Survey contained additional questions meant to assess boaters' perceptions of various aspects of water conditions (including pool levels and water quality), amount of boat traffic, and interactions with others on the water. Respondents were also asked to evaluate the adequacy of the number of boating-related facilities. Responses to each of these questions were summarized for the Study R-13 – *Recreation Surveys* report and are reiterated here. Boater group characteristics are also summarized, including group size, primary boating activities, and average length of stay.

A total of 2,583 visitors completed the Recreation On-Site Survey; of those, 1,361 (53 percent) identified themselves as boaters and completed the boater-only section. A total of 1,071 usable Mail-Back Surveys were returned. The survey results reported here include only responses from visitors who boated during their visit to the Oroville area, whether the survey question was contained in the general or boater-only section of the survey booklets. However, all responses to the Recreation Mail-Back Survey questions related to boating are reported; respondents (in particular, non-boaters) could circle "N/A" for questions or items that they felt did not apply to them or about which they had no opinion.

Additional information was obtained from a more limited number of boaters surveyed at three other northern California lakes as part of a Similar Site Survey. About 100 visitors were surveyed at each lake during one or two summer 2002 weekends. These surveys provided information to compare boaters' perceptions at those other reservoirs to boaters' perceptions at Lake Oroville, and information on boaters' (at the similar sites) perceptions of Lake Oroville.

4.5 RESERVOIR BOATING CAPACITY

This capacity analysis was conducted in conjunction with Study R-8 – *Recreation Carrying Capacity Analysis*. The overall purpose is to determine the maximum amount of use of a particular type an area can sustain without excessive detrimental effects to the natural resource, facilities, or visitors' recreation experience. This hypothetical amount of use is determined by the respective limiting factor for each respective area.

A limiting factor is defined as anything that limits or puts a cap on the level of recreational use (capacity) at a site or area. For example, the number of boat launches and associated parking available (facility capacity) might limit boating if all parking is full or long waits are required to launch. If boating activity on the water has no space to expand or is constrained by narrows or shallows, physical capacity might be exceeded. If a boating area is located next to sensitive wildlife or vegetation resources, impact to these resources might be considered ecologically limiting. Finally, if a body of water or segment is perceived as extremely crowded or there are excessive user conflicts, social capacity may be exceeded, no matter what the use level is. For each reservoir (and the six zones of Lake Oroville, as described above), conclusions were made regarding

which of the four capacity types is or could be a limiting factor(s). Qualitative and quantitative data were used to make these conclusions.

Once identified, these limiting factors became the focus for assessing recreation capacity at Project Area reservoirs and for potentially monitoring boating capacity in the future. While all four capacity types (ecological, facility, physical/spatial, and social) are considered potentially limiting, use level is primarily constrained in most areas by only one or two of these factors.

Based on the evaluation of limiting factors, an overall assessment of reservoir and reservoir-segment boating capacity was developed. This assessment characterized boating use levels in relation to capacity using four general conditions: below, approaching, at, or exceeding capacity. Typical weekend afternoons and holiday weekend afternoons were considered from Memorial Day to Labor Day weekend.

Ecological capacity was assessed by reviewing results of other studies conducted under the direction of the Recreation and Socioeconomics Work Group (RSWG) and the results of studies conducted under the direction of the Environmental Work Group. Study R-11 – *Recreation and Public Use Impact Assessment* provided information from field observation of physical resource impacts. Environmental work group studies reviewed for this study include Study W-3 – *Recreational Facilities and Operations Effects on Water Quality* and Study T-9 – *Recreation and Wildlife*.

The physical/spatial capacity of reservoir segments was assessed using data on the number of boats counted and the current surface water acres in each segment. Dividing surface acres by boats counted produced an acres-per-boat traffic density figure. These values were then compared with a theoretical average number of surface water acres needed per boat (i.e., a boating density or space standard).

Various boating density standards for the surface water acreage needed by boaters have been developed and used over the years. These standards range from as few as four to as many as 40 surface water acres per boat, with the larger acreage standards used for space-dependent activities such as waterskiing and PWC use within narrow areas. The standards are subject to variation based on reservoir-specific factors such as water depth, shoreline configuration, visitors' perceptions, number of accidents involving other boats, boat type and speed, dominant boating activities, and the types of activities that are popular on the water and on the shoreline.

Recently, researchers have adapted the land-based Recreation Opportunity Spectrum (ROS) concept developed by the U.S. Forest Service to apply to water-based recreation capacity and management (Haas et al. 2003). Using this adapted water ROS (WROS) system, boating density standards are dependent on the setting classification(s) of different zones of a lake or reservoir. Surface water acres per watercraft space standards in the WROS system range from as few as 1–10 surface water acres per watercraft in an urban setting, managed for high levels of use, to as many as 3,200

surface water acres needed per watercraft in a primitive setting managed for very low levels of use.

This study developed and applied a set of space standards based on review of standards applied at three other western U.S. reservoirs in recent years, the new guidelines developed for the WROS system, and professional judgment based on boating research and management experience at large reservoirs across the U.S. Social capacity by reservoir segment was assessed by analyzing survey data on boaters' perceptions of crowding on the water and their perceptions of problems related to interactions with other boaters.

Facility capacity by reservoir segment was assessed by reviewing parking utilization levels at boater facilities, information reported by boaters about wait times to launch, and boaters' perceptions of the adequacy of facilities.

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5.0 STUDY RESULTS AND ANALYSIS

The study results are divided into five sections. Section 5.1 summarizes local (Project Area reservoir) boating issues, principally issues related to boating safety and regulation. Section 5.2 provides a description of the amount, type, and distribution of boating use on the Project Area reservoirs. Section 5.3 summarizes the condition of the boating infrastructure, and how boating facilities are affected by reservoir pool levels. Section 5.4 summarizes the results of survey questions related to reservoir boating. Last, Section 5.5 addresses surface water boating capacity.

5.1 LOCAL BOATING ISSUES

The Recreation and Socioeconomic Work Group (RSWG) of the Project 2100 Relicensing Collaborative identified issues and information related to boating safety and regulation on the Project reservoirs. Issues of interest included boating accident statistics, law enforcement problems, regulations and management provided by law enforcement agencies and park managers, and boating issues related to changes in Lake Oroville pool elevations. Also of interest were issues expressed by boaters in response to surveys conducted for Study R-13 – *Recreation Surveys*.

5.1.1 Boating Accident Statistics

Boating accident statistics collected by DBW and DPR for Project reservoirs as well as other waterways in California are summarized below. Boating accident statistics were not available for Thermalito Forebay or the Diversion Pool. Additional information regarding accidents in the study area is provided in Study R-2 – *Recreation Safety Assessment*.

5.1.1.1 Statewide Boating Accidents

DBW has produced the *2001* and *2002 California Boating Safety Reports* (DBW 2002, 2003), which analyze reported boating accidents in California for the previous year and provide data for the previous 10 years. An accident is considered reportable if: a person dies, disappears, or is injured requiring medical attention beyond first aid; vessel or other property damage exceeds $500; or there is complete loss of a vessel. It is important to note that some accidents that meet these criteria go unreported for a variety of reasons, including lack of awareness about reporting requirements and non-compliance. These data provide context to data specific to the Project Area.

There were 907 boating accidents in California reported during 2001, and DBW recorded 911 accidents in 2002. In 2002, there were 468 injuries, 53 fatalities, and $3.7 million in property damage attributed to these accidents. The 10-year high for reported accidents in California was 925 accidents, recorded in 1997 (a high-water year). The highest number of reported injuries occurred in 1996, with 537. The highest number of fatalities occurred in 1993, with 67. The number of accidents and injuries increased during the mid- to late-1990s, and appears to have leveled since. The only exception was in 1998, which had a relatively low accident and injury total. The number of fatalities does not appear to follow any identifiable trend.

The reports cite that the majority of the accidents occurred on weekends and holidays between May and September between 2:00 and 4:00 p.m. These are typically the busiest boating dates and times. In addition, roughly one-fourth of all accidents occurred during the three summer holiday weekends: Memorial Day, Independence Day, and Labor Day (DBW 2002, 2003).

5.1.1.2 Lake Oroville Boating-Related Accidents

Information regarding boating accidents at Lake Oroville from 1997 to 2002 was obtained from DBW and DPR. A total of 63 reported accidents, causing 44 injuries and 1 fatality, occurred during that period. The most common types of boating accidents were collisions with other vessels and skier mishaps. These two causes also led to the most boating injuries. There were about two-thirds as many injuries as there were accidents. The only fatality reported during this time period was a result of a boat capsizing. There is no clear trend in the total number of accidents over the 6 years, although there was a significant decline in the number of accidents occurring in 2002. With the exception of boats colliding and skier mishaps, the other types of accidents appear to be isolated incidents.

As expected, the majority of accidents at Lake Oroville occur in the summer months. Most accidents and injuries occurred in July and August, followed by June and September. These results are not surprising as it coincides with the warm weather boating season. There have been no reported accidents in January, but every other month has had at least one accident. The only recent boating-related fatality occurred in June 1999. The area around Bidwell Canyon had the most accidents in 2002, followed by the South Fork portion of the reservoir.

Accident data for Lake Oroville was compared with data from other major northern California lakes and reservoirs. In 2001, Lake Oroville had fewer reported accidents (14) than Shasta Lake, Folsom Lake, and Lake Berryessa, and about the same number of accidents as Lake Tahoe. In 2002, there were significantly fewer reported accidents at Lake Oroville (4) than at the other Northern California lakes. The lower accident total may be a reflection of lower use in 2002 due to low water levels, but otherwise may suggest an encouraging trend. In comparison, Shasta Lake had 57 boating accidents in 2001 and 60 accidents in 2002, the most of any northern California lake or reservoir. Shasta Lake also had the most boating injuries, with 27 in 2001 and 35 in 2002 (DBW 2002, 2003a). Table 5.1-1 provides comparative information on the above lakes and reservoirs.

Table 5.1-1. Comparative statistics for major northern California lakes and reservoirs.

Lake/Reservoir	Surface Acreage[1]	Miles of Shoreline	Boat Ramps	Marinas
Folsom Lake	12,000	75	4	1
Lake Oroville	**15,800**	**167**	**5**	**2**
Lake Berryessa	21,000	165	8	7
Shasta Lake	29,500	370	14	12
Lake Tahoe	122,000	72	11	15

1. Acreage figures for reservoirs are for full pool (does not apply to Lake Tahoe).
Source: EDAW 2003a.

5.1.1.3 Personal Watercraft-Related Accidents (Statewide and Lake Oroville)

The *2001* and *2002 California Boating Safety Reports* (DBW 2002, 2003a) address PWC-related accidents in California. In 2001, PWCs represented 19 percent of the registered boats in California, but were involved in 30 percent of the accidents and represented 43 percent of the injuries. In 2002, they accounted for 18 percent of registered boats in California and were involved in 28 percent of the reported accidents. However, accidents involving PWCs have declined significantly in the State since 1997, with 391 reported accidents in 1997 and 253 in 2002. This Statewide trend is consistent with the apparent trend at Lake Oroville, where there were six reported accidents in 1997, two in 2001, and two in 2002.

DBW attributes the reduction in PWC-related accidents to two new laws that took effect in 1998. The first raised the minimum age to operate a PWC from 12 to 16 years old. The other law prohibits wake jumping within 100 feet of other watercraft. It is also important to note that most (72 percent) of the accidents attributed to PWCs use involved renters or borrowers of PWCs. The most common causes of boating accidents involving PWCs are: operator inexperience, excessive speed, and operator inattention. DBW reports state that PWCs account for a disproportionately high number of accidents even when accounting for time on the water. There is one accident for every 666 hours of PWC operation on California waterways, compared to one accident for every 788 hours of operating conventional watercraft.

5.1.1.4 Thermalito Afterbay Boating-Related Accidents

Boating accident data for Thermalito Afterbay were obtained from DBW. Between 1997 and 2002, there were eight reported accidents, seven injuries, and one fatality. Seventy-five percent of the accidents and all of the injuries at Thermalito Afterbay during that time period were caused by boater collisions with other vessels. The only fatality at Thermalito Afterbay during this period was caused by a fall overboard, which occurred in April 2001. Unlike Lake Oroville, over the last six years, the month with the most reported accidents and injuries at Thermalito Afterbay was April, with three accidents and injuries. Interestingly, even February had more reported accidents (2) than any summer month.

5.1.2 Boating Law Enforcement Problems

Representatives of agencies responsible for recreation safety in the study area were interviewed for Study R-2 – *Recreation Safety Assessment*. The goal of the interviews was to identify issues related to recreation safety from the point of view of law enforcement and land and resource managers. Representatives from the following responsible agencies were interviewed: DWR, DPR, DFG, and the Butte County Sheriff's Office.

Of specific interest for this study are the recreational boating law enforcement issues identified during the interviews. Many of these are consistent with Statewide boating safety issues identified in *California Boating Safety Reports* (DBW 2002, 2003). The following safety-related issues were identified by one or more interviewees:

- Boaters often exceeding the 5 mph limit in designated zones;
- PWC users jumping wakes and following other boats too closely;
- Alcohol use while boating;
- Perceived shortage of enforcement officers;
- Boaters not wearing personal floatation devices (PFDs);
- Aquatic plants getting caught in the jets of PWCs or jet boats;
- Daily water fluctuations at Thermalito Afterbay; and
- Seasonal water level changes at Lake Oroville.

Daily water fluctuations at Thermalito Afterbay were noted both by the Butte County Sheriff's Office and DFG. There have been boating accidents in areas that are several feet deep one day, but only several inches deep the next. It was noted that property damage has occurred (including motors or propellers being damaged), and that the fluctuation is a potential hazard to both motorized and non-motorized craft (e.g., sailboats and sailboards).

5.1.3 Reservoir Boating Regulations

Boating on each of these reservoirs is subject to the general regulations for boating within California, as outlined in the *2003 ABCs of California Boating Law* (DBW, 2003). Boaters must comply with the provisions of the *ABCs* regarding registration, equipment, accident procedures, navigation, operations, and other issues. The following elements of the *ABCs* are of particular relevance with respect to general boating at the Oroville-Thermalito complex:

Boats must maintain safe speeds at all times so that action can be taken to avoid collision and a boat can stop within an appropriate distance; and
The maximum speed for boats within 100 feet of a bather and/or within 200 feet of a bathing beach, swimming float, diving platform, occupied landing, or life line is 5 miles per hour (mph).

In addition to general State regulations, boating within the Project area is also subject to the regulations of resource agencies that administer the use of particular reservoirs in

the complex. Within the Project area, DPR administers the use of reservoirs in the LOSRA, including Lake Oroville, Thermalito Diversion Pool, and Thermalito Forebay. DFG administers the use of Thermalito Afterbay, though patrol and enforcement there is generally provided by Butte County Sheriff's Office under contract with DWR. Several key resource agency regulations pertaining to boating on the respective water bodies are outlined below.

5.1.3.1 Lake Oroville Boating Regulations

Both motorized and non-motorized craft are allowed by DPR on Lake Oroville. Boats may not be operated in areas within 50 feet of the boundaries of designated swimming areas as marked by buoys placed 50 feet apart (and by signs on the shore). Signs placed at the top of the boat ramps inform boaters that the maximum speed limit is 5 mph within 200 feet of the shoreline, within 100 feet of any swimmer, and during the period one-half hour after sunset to one-half hour before sunrise. Wastes from boats (including shower water and human waste) must be discharged into a holding tank and may only be discharged in onshore disposal facilities. The two marinas on the lake provide pump-out service for boats with holding tanks.

5.1.3.2 Thermalito Diversion Pool, Forebay, and Afterbay Boating Regulations

DPR allows only non-motorized boats and boats with electric motors on Thermalito Diversion Pool (electric motors are generally small—five horsepower or less). A floating buoy line just downstream of the Oroville Dam spillway marks the farthest point upstream where any boat is permitted, about one mile downstream from the dam itself. A similar buoy line is in place about one-half mile upstream from the Diversion Dam, and marks the farthest downstream point where boats are permitted.

Both motorized and non-motorized craft are allowed by DPR on the south half of Thermalito Forebay (south of the Nelson Avenue bridge) while only non-motorized boats are allowed on the north half (north of the bridge). Motorized boats may not be operated within 50 feet of the boundaries of designated swimming areas as marked by buoys placed 50 feet apart (and by signs on the shore). The maximum speed limit for motorized boats on the South Forebay from sunset to sunrise is 5 mph.

Both motorized and non-motorized craft are allowed by DFG on Thermalito Afterbay, which is managed as part of the OWA. State regulations for wildlife areas state that "boat speeds shall not exceed 5 miles per hour" (California Code of Regulations - Title 14 2003). Wastes from boats (including shower water and human waste) must be discharged into a holding tank and may only be discharged in onshore disposal facilities. No pump-out facilities are provided, but boats used on Thermalito Afterbay are generally not the large types that have on-board restrooms or holding tanks.

The 5 mph speed limit on Thermalito Afterbay conflicts with current use, as Thermalito Afterbay is popular with PWC users and water-skiers, whose normal operation of their watercraft clearly exceed this speed.

5.1.4 Changes in Reservoir Pool Elevation and Effects on Reservoir Boating

The pool level of Lake Oroville changes substantially during the yearly cycle of drawdown and refilling of the reservoir. The amount of change varies widely from year to year as does the date when the pool level crosses certain thresholds important to boating access. This section describes the fluctuation of the pool level during the 2002–2003 study period and the 12 years prior to 2002, how those fluctuations affected boating access, and how they may have affected boating safety and enjoyment.

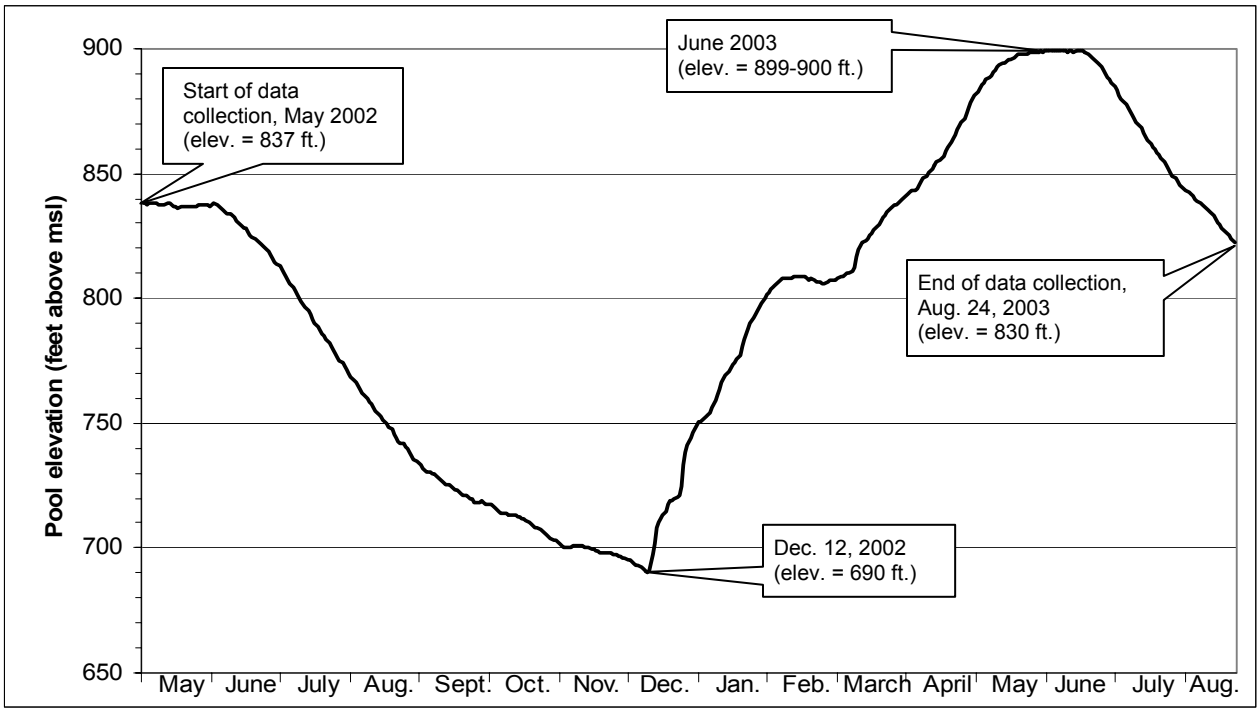
5.1.4.1 Lake Oroville Pool Elevations, Summer 2002 to Summer 2003

Counts of boats on the water and other observations made on Lake Oroville for this study began Memorial Day Weekend, 2002, and concluded in late August 2003. Large differences in pool levels between the two years provided the opportunity to observe a wide range of boating conditions for this study. Figure 5.1-1 depicts the daily reservoir pool level during the 16-month data-collection period.

Lake Oroville's pool elevation during the 2002 summer peak boating season ranged from about 837 feet above msl in mid-May to 725 feet above msl in mid-September, a range of about 112 feet (all pool elevations stated from this point forward are elevations above mean sea level.) The pool elevation held steady through May, then fell slightly more than one foot per day, on average, through June, July, and August. The reservoir reached its minimum elevation for the year on December 12 at about 690 feet, its lowest elevation in more than 10 years.

Reservoir pool levels were quite different during 2003. By the end of January, the pool had nearly returned to the 800-foot level. A steady rise continued through most of the spring months, averaging about one foot elevation gain per day through March, April, and May. The reservoir reached the near full-pool elevation of 899.5 feet on June 8 and remained within a few feet of that elevation through the month. The usual summer drawdown began in late June, and the pool fell from 1 to 1.5 feet on most days through July and August. The reservoir was at an elevation of about 830 feet on the date of the last on-water boat count, August 24, 2003. This was considerably greater than that date in 2002, which had a pool elevation of 742 feet.

Figure 5.1-1. Lake Oroville daily pool elevation, May 2002–August 2003.



Source: DWR 2003.

5.1.4.2 Historic Lake Oroville Pool Elevations

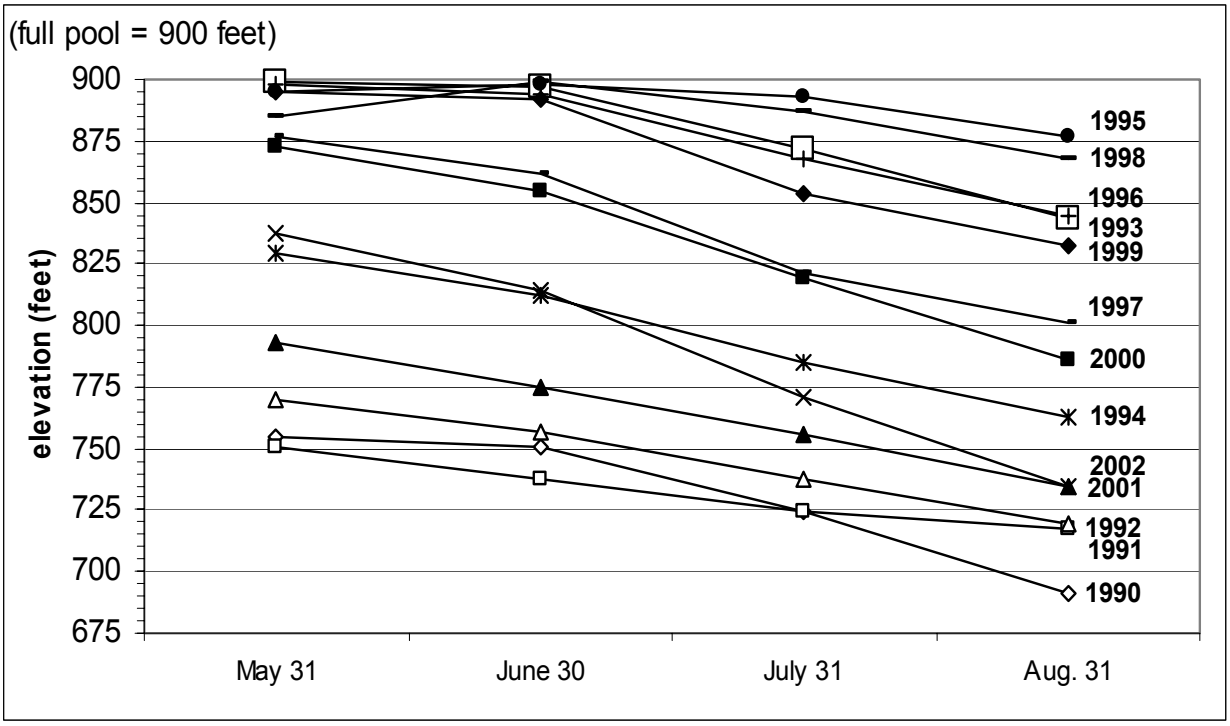
Lake Oroville elevations throughout the year—and during the peak recreation months from May to September, in particular—have varied widely since the reservoir was first filled in 1968. The typical annual pattern is for the reservoir to fill through the late winter and spring until it reaches a maximum elevation for the year in May or June. The reservoir then drops 6–12 inches per day throughout the summer and fall seasons until it reaches a minimum elevation in December or January. Factors such as precipitation in the watershed, the timing of downstream water demands, and environmental requirements affect how high the reservoir rises by the start of the season in May and how low it drops, and at what rate, through the rest of the year.

Lake elevation data for the 13 years from 1990 to 2002 highlight the variability in reservoir elevation from year to year, in particular during the peak boating season. Figure 5.1-2 illustrates the range of summer pool levels across the 13 years, which include water years classified as dry years (e.g., 1990–92, 2000–01), normal years (e.g., 1993), and wet years (e.g., 1995-96).

Elevations at the end of May (just after Memorial Day Weekend, which is the traditional start of the peak recreation season) ranged from a low of 751 feet in 1991 to a high of 899 feet (near-full) in 1993. The reservoir was also within a few feet of full pool at the end of May in 1995, 1996, and 1999. In some years, the reservoir reached its high elevation for the year before the end of May, while in others, the high elevation was not reached until mid- or late June. Pool elevation at the end of August (near the beginning of the Labor Day Weekend, after which recreational activity often slows) varied from a

low of 691 feet in 1990 to a high of 877 feet in 1995. The end-of-May to end-of-August drawdown total since 1990 has usually ranged between about 50 and 75 feet. However, the drawdown was less than 20 feet in 1995 and 1998, and was over 100 feet during 2002.

Figure 5.1-2. Lake Oroville end-of-month pool elevations, May–August, 1990-2002.



Source: DWR 2003.

The annual range in pool elevation for these years was as little as 62 feet (during 1996) and as much as 178 feet (during 1993) and averaged 112 feet. The difference between the high and low elevations during 2002 was 148 feet.

5.1.4.3 Potential Effects of Changes in Lake Oroville Pool Elevation on Boating Safety and Enjoyment

Lake Oroville's great variation in reservoir water level from one year to another and within some years affects boating and other recreation. How low the pool level falls determines how large an impact low water levels will have on boating facilities and activities and how much surface area will be available for boating.

There was a 7,000-acre difference in surface area between the 690-foot minimum and 900-foot maximum pool elevations experienced during the study period (surface area ranged from 8,000 acres to more than 15,000 acres, respectively). Less surface area for a given amount of use will result in higher boat traffic density. If this occurs during the peak use season, greater traffic density could contribute to more boating-related

accidents. Greater traffic density may also increase boaters' perception of crowding. Generally, the greatest reductions in surface area associated with low pool levels do not occur until the fall and winter, when boating activity is moderate or low, and when few pleasure boaters are on the lake (most fall and winter boaters are fishermen).

Boating hazards also differ depending on water depths. Submerged objects can become potential hazards as the reservoir level lowers, as it normally does during the summer season. At full pool, the number of sites where underwater obstructions are near the surface are relatively few. As the pool falls, several peninsulas—in the main basin and Middle Fork arms in particular—become exposed or approach hazardous sub-surface levels. Several small islands also appear in the South Fork arm in the area of Stringtown and Enterprise. Figure 5.1-3 depicts areas that are exposed at the 840-foot elevation typical of mid-summer and at the 800-foot elevation, which the lake level typically falls below in dry years. The larger of these hazard areas are marked by hazard buoys maintained by DPR. In addition to posing safety concerns, the exposed land acts as a barrier to navigation and limits the water skiing, cruising, and other boating activity in the area.

At lower water levels, submerged standing trees retained for fish habitat appear at and just below the surface, primarily in the backs of certain coves and at the upper reaches of the South Fork arm. There are 18 such vegetation retention sites on Lake Oroville, each covering from 15 to 170 acres and totaling about 1,100 acres (pers. comm., See 2003).

These potential hazards were observed at or near the surface of the lake during early August of 2002, when the reservoir level was approximately 765 feet. However, in most years these trees are well below the surface until the fall and winter, when general-recreation boating is light. As stated above, most boaters on the lake during the fall and winter are anglers, some of whom use areas with standing timber because of the enhanced fishing they provide.

Prominent signs at all of the primary boat ramps provide the following warning to boaters:

DANGER (within a yellow diamond)
LAKE LEVEL CHANGES DAILY
SUBMERGED OBSTACLES
WATCH FOR UNMARKED HAZARDS

Figure 5.1-3. Lake Oroville shoreline at various pool elevations.

[8.5 x 11 insert]

5.1.4.4 Effects of Changes in Lake Oroville Pool Elevation on Boat Ramp Usability

How low the Lake Oroville pool elevation falls and when it falls below certain critical elevations are important boating issues due to effects on the usability of the primary boat ramps. Low lake levels during the mid-May to mid-September peak boating season are of particular interest. Ramp closures due to low water cause inconvenience for boaters and put added pressure on the remaining open ramps.

DWR extended the boat ramps at Bidwell Canyon, Spillway, and Lime Saddle during December 2002. The extensions allow the ramps to be used at elevations 10–30 feet lower than previously possible. The lower Spillway ramp now has two lanes usable down to an elevation of 695 feet, the 3-lane lower Bidwell Canyon ramp has been extended down to 700 feet, and the Lime Saddle ramp provides two launch lanes down to 702 feet. Before 2002, March 1991 was the last time that Lake Oroville fell below 695 feet, and the reservoir had not been lower than 702 feet since December 1992. Thus, judging by this historic reservoir elevation data, the ramps are likely to be usable year-round most years. (Study R-3 – *Assessment of the Relationship of Project Operations and Recreation* provides more detailed information on historic Lake Oroville elevations.)

The two other paved boat ramps on the lake, at Loafer Creek Campground/DUA and Enterprise BR, do not reach to such low elevations. The Loafer Creek BR provides two launch lanes down to 775 feet, and the 2-lane Enterprise BR is usable down to about 835 feet.

Specific effects of low pool levels on the usability of the primary Lake Oroville boat ramps and car-top ramps, both as observed during the 2002–03 study data collection period and probable future effects indicated by historical pool level data for the previous 12 years, are addressed in Section 5.3 (Assessment of Boating Infrastructure) of this report.

5.1.4.5 Effects of Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay Elevation Changes on Boating Access, Safety, and Enjoyment

Both Thermalito Diversion Pool and Forebay normally have minimal fluctuations in surface elevation. Storage data reported in the DWR *State Water Project Operations Data* monthly reports (DWR 2002) for Thermalito Diversion Pool and Thermalito Forebay indicate that storage (and thus elevation) changed only slightly from day to day during the 2002 recreation season. Only electric motors are permitted on the Diversion Pool and only non-motorized boats are permitted on the north half of Thermalito Forebay, so any fluctuations that do occur would pose less danger to boaters. The bathymetry of Thermalito Forebay is such that underwater hazards are few at normal elevations.

Overall, surface elevation fluctuates much less in Thermalito Afterbay than in Lake Oroville, but daily fluctuation may be as great or greater. During the 2002 summer

recreation season, the elevation of Thermalito Afterbay fluctuated between approximately 125 and 132 feet. However, the elevation can change quickly—by as much as 3 or 4 feet in 24 hours. The changes in elevation follow a weekly cycle dictated by hydropower operations and can be generally characterized by a gradual increase in elevation from Monday through Friday followed by a more rapid decrease in elevation during the weekend. Two- to three-foot reductions in pool level from Saturday to Sunday are common.

The boat ramps on Thermalito Afterbay are not greatly affected by the pool level fluctuations. The Wilbur Road and Monument Hill ramps are long enough to be fully functional at all normal pool levels. Both ramps are equipped with floating docks that adjust to the fluctuating water level.

As noted in Section 5.1.2.1, the agencies that enforce boating laws and respond to accidents on Thermalito Afterbay have noted the occurrence of boats hitting bottom when they were not aware of a large drop in pool level and its effect on water depth in near-shore areas., Excluding the possible effects of these shallow areas at lower pool levels, the fluctuations are unlikely to reduce enjoyment of boaters due to crowding or limits to navigation given the large open areas available at all elevations and low use levels at all times.

5.1.4 Other Issues of Concern Identified by Boater Surveys

Boaters had the opportunity through the On-Site and Mail-Back Surveys conducted in the study area to express their opinions and experiences related to a range of issues of concern. Several issues of importance to boaters were identified during the study planning process, and survey questions were formulated to solicit boaters' and others' opinions on each of the issues. The following four groups of boating-related issues were addressed within the visitor surveys:

1. Unsafe boater behavior experienced or observed by boaters;

2. Boaters' perceptions of potential social problems (number of boats on the water; boat noise, speed and wakes; encounters with other types of boaters);

3. Boaters' perceptions of potential water level/water condition problems primarily related to low pool levels (exposed land and shallows at low pool levels, water level fluctuations, debris in the water, and water quality);

4. Boaters' opinions of the adequacy of the number of boating facilities (boat ramps, docks or temporary moorage, boat-in campsites, marinas, and boat-in gas stations).

Section 5.5 of this report is devoted to reporting on these issues and other aspects of boaters' perceptions and boater group characteristics, as determined through the survey results. Survey methods and samples obtained are also described.

5.2 DESCRIPTION OF BOATING ACTIVITY ON PROJECT AREA RESERVOIRS

This section summarizes reservoir boating use levels for each of the four Project Area reservoirs: Lake Oroville, Diversion Pool, Thermalito Forebay, and Thermalito Afterbay. Boating use levels for Lake Oroville are summarized for the reservoir as a whole and for the six zones of the lake established for this study.

All data reported were gathered during 37 Project-wide reservoir boat traffic observations conducted between May 2002 and August 2003. Data for the peak boating season of Memorial Day weekend through Labor Day weekend are presented first, followed by data for the non-peak season months between late January and Memorial Day weekend of 2003. No data were collected between mid-September 2002 and late January 2003, primarily due to very low water levels in Lake Oroville.

5.2.1 Peak Season Boating Use

This section describes boating use observed on the Project Area reservoirs during 21 peak-season observation days; three of these were holidays, 12 were non-holiday weekend days, and six were weekdays. The majority of the data were obtained during 16 observations completed during the peak seasons of 2003, when Lake Oroville water levels were moderate to high. Of the 16 observations in 2003, 2 were conducted on holidays, 8 on non-holiday weekends, and 6 on weekdays. The four weekend observations and one holiday observation completed during the 2002 peak season are more representative of the low-water conditions that existed most of that period on Lake Oroville. No weekday observations were conducted during 2002. Because water levels do not vary annually on the downstream reservoirs, no distinction is made between the 2002 and 2003 counts at these sites.

5.2.1.1 Peak Season Reservoir-Wide Boating Use Levels on Lake Oroville

Discussion of peak season Lake Oroville use levels begins with a summary of overall use levels and description of that use (active versus inactive boats, boat types).
Number of Boats on the Water

The counts documented that boating activity is highest on summer holiday weekends. The three holiday counts, conducted during Labor Day weekend of 2002 and Memorial Day and Independence Day weekends of 2003, were the highest of any of the counts obtained (Table 5.2-1). The counts on the first two of those holidays were slightly less than 700 boats, while the count on Independence Day weekend (Saturday, July 5, 2003) was well over 1,000 boats. The holiday average was 816 boats.

Weekend counts of boats during the 2002 and 2003 peak seasons averaged 421 boats. The average for 2002 was about 320 boats, while the average for 2003 was about 490 boats, an increase of about 50 percent. (Two of the 2002 counts were completed in the morning and early afternoon, when boat traffic would normally still be increasing, likely resulting in underestimation of boating use on those days and in 2002.) Weekday counts averaged 180 boats, about 43 percent of the weekend average.

Both weekend and weekday boat traffic deviated widely from these averages. The weekend counts during 2003 ranged from 665 boats on June 28, to 322 boats on August 24, a decrease of over 50 percent. (The reservoir was at the near-full pool elevation of 897 feet on June 28 but had fallen to about 830 feet by August 24.) Similarly, weekday counts ranged from 227 boats observed on August 12, to 140 boats observed on August 20, a decrease of nearly 40 percent. (The pool elevation differed only by about six feet between those dates).

Active vs. Beached or Moored Boats

Between 45 and 60 percent of boats were in active use during most of the weekend counts, with the remaining 40–55 percent beached or moored on or near shore. Many of the beached boats were houseboats, which commonly congregate along the shore in coves that provide calmer water and shelter from wind. Many of the houseboats had one or two other smaller boats (e.g., runabouts, PWC) alongside, which boaters use to cruise the lake while the houseboat serves as a "base camp." The percent of beached boats tended to be highest on holidays, when many houseboats were in use. For example, about two-thirds of the 1,064 boats observed on July 5, 2003 were beached or moored boats.

Table 5.2-1. Peak season counts of watercraft on Lake Oroville (2002 and 2003).

	Count Date	Lake Oroville Zones												All Zones	
		Main Basin		Middle Fork		South Fork		Lower N. Fork		Upper N. Fork		West Branch			
		Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats
Holidays	8/31–9/2/02[a]	67	99	97	290	58	155	49	76	23	28	31	40	325	688
	5/25/03	90	154	87	211	29	118	21	67	27	42	53	104	307	696
	7/5/03	93	393	106	289	77	175	20	63	26	49	27	95	349	1064
	Average	**83**	**215**	**97**	**263**	**55**	**149**	**30**	**69**	**25**	**40**	**37**	**80**	**327**	**816**
Weekends	6/16/02	42	52	15	51	3	33	34	45	32	46	27	43	153	270
	6/23/02[b]	32	32	26	75	25	39	43	45	13	13	71	91	210	295
	7/13/02[b]	36	38	85	149	40	67	22	22	33	33	16	24	232	333
	8/3-4/02	33	47	58	127	44	88	16	32	33	37	33	55	217	386
	6/1/03	61	93	110	139	59	68	35	38	40	42	30	39	295	377
	6/15/03	85	135	85	151	37	64	NA	NA	NA	NA	NA	NA	---	---
	6/28/03	63	160	65	153	63	115	52	82	31	44	66	111	340	665
	7/20/03	69	136	65	146	55	111	NA	NA	NA	NA	NA	NA	---	---
	7/26/03	65	126	95	229	59	179	18	26	16	25	22	34	275	619
	8/3/03	71	109	63	113	42	107	16	26	10	15	13	21	215	391
	8/16/03	56	80	66	191	68	185	12	30	25	38	21	28	248	552
	8/24/03	61	80	37	100	33	59	13	24	18	25	26	34	188	322
	Average	**52**	**82**	**62**	**133**	**44**	**94**	**26**	**37**	**25**	**32**	**33**	**48**	**237**	**421**
Weekdays	6/12/03	28	51	20	28	4	14	9	15	17	19	16	22	94	149
	6/18/03	19	52	27	37	20	35	NA	NA	NA	NA	NA	NA	---	---
	7/8/03	18	59	25	62	9	32	11	18	7	14	14	20	84	205
	8/12/03	37	41	22	66	12	60	9	14	12	16	25	30	117	227
	7/22/03	28	47	16	47	16	42	NA	NA	NA	NA	NA	NA	---	---
	8/20/03	28	37	16	43	16	47	2	2	5	6	5	5	72	140
	Average	**28**	**47**	**21**	**50**	**10**	**38**	**8**	**12**	**10**	**14**	**15**	**19**	**92**	**180**

Notes: Peak Season is Memorial Day weekend through Labor Day weekend. NA means data is not available for that zone and date, a dash means no Lake Oroville total is listed because no data is available for some zones.
a. The Labor Day holiday weekend counts were conducted over three consecutive afternoons. Partial counts conducted during the 2002 Memorial Day and Independence Day weekends are not reported since complete counts were conducted on those weekends during 2003.
b. These counts were conducted during the morning and early afternoon (9 am to 1 pm), before boat traffic likely reached its peak for the day.
Source: EDAW 2003a.

Types of Boats Observed

More than half of the boats observed on Lake Oroville during the peak season were in the "runabout" category (Table 5.2-2). (This category was applied broadly to include specialized ski and wake-board boats, as well as the few cabin cruisers observed.) Next most common were houseboats, with an average of 92 observed each count, and which comprised about 20 percent of all boats observed. Several hundred houseboats are moored at each of the two marinas on the lake, and the marinas rent houseboats as well. Third most common at 11 percent were PWC (i.e., jet-skis), which were commonly associated with houseboats. Fishing boats (primarily "bass boats") were slightly fewer in number. Most of the remaining boats were pontoon boats (many of which were also marina rental units) and non-motorized boats (primarily sailboats).

Table 5.2-2. Average number of watercraft and proportion of Lake Oroville use by type during the 2002 and 2003 peak seasons.

Watercraft Type												ALL TYPES	
Run-abouts[1]		Personal W'craft		House Boats		Fishing Boats		Pontoon Boats		Non-Motorized			
#	%	#	%	#	%	#	%	#	%	#	%	#	%
216	51	47	11	88	21	40	9	23	5	10	2	424	100

Note: Peak season is Memorial Day weekend through Labor Day weekend. Data include all boats observed on 21 holiday, weekend, and weekday counts.
1. The runabouts type includes ski boats, wake-boarding boats, and cabin cruisers.
Source: EDAW 2003a.

5.2.1.2 Peak Season Boating Use on Lake Oroville by Zone

This section describes each of the six zones of Lake Oroville designated for the purposes of this study and provides a summary of the number and types of boats observed using each area. Figures 5.2-1 and 5.2-2 depict the average peak season weekend and holiday boat counts (active and total boats) for each zone.

At least 17 peak season counts were conducted on each of the 6 zones of Lake Oroville, with the more heavily used zones receiving 21 counts. (Two holiday counts conducted during the 2002 season that did not cover all zones are not included in the data summarized here in favor of complete counts conducted during the 2003 season.)
Main Basin Zone

This zone contains the Bidwell Canyon Marina, which occupies most of the Bidwell Canyon cove at the south end of the zone. Because few boats use the back of the cove beyond the marina, counts were not conducted at the back of the cove. This zone also contains three of the four major boat ramps on the reservoir, and the Foreman Creek Car-top BR. Four floating campsites were moored in two coves. Relatively little traffic was observed in the central portion of the two-mile wide basin. Many of the boats in that area appeared to be in transit to or from boat ramps or the marina.

Figure 5.2-1. Peak season weekend boating use.

[8.5 x 11 insert]

Figure 5.2-2. Peak season holiday boating use.

[8.5 x 11 insert]

An average of 82 watercraft were counted on the Main Basin on peak season weekends, and an average of about 47 were counted on weekdays (Table 5.2-3). The highest single watercraft count on the Main Basin was nearly 400, observed during the 2003 Independence Day weekend. The holiday average was 215 boats. Most of these were moored or beached in coves near the Bidwell Canyon BR and the Loafer Creek DUA. The boat traffic observed on the Main Basin comprised about 20–25 percent of the traffic observed lake-wide (Table 5.2-3). It was generally the second- or third-most used zone on the lake in each count.

Table 5.2-3. Average number of watercraft and proportions of total Lake Oroville watercraft use by lake zone during the 2002 and 2003 peak seasons.

	Lake Oroville Zone												ALL ZONES	
	Main Basin		Middle Fork		South Fork		Lower N. Fork		Upper N. Fork		West Branch			
Count Type	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Holidays	215	26	263	32	149	18	69	8	40	5	80	10	816	100
Weekends	82	19	133	32	94	22	37	9	32	8	48	11	421	100
Weekdays	46	24	57	30	46	24	11	6	12	6	18	10	191	100

Note: Peak season is Memorial Day weekend through Labor Day weekend. Percentages may not sum to 100 percent due to rounding error. Data do not include 2 weekend and 2 weekday count dates with no data for the Lower North Fork, Upper North Fork, and West Branch zones.
Source: EDAW 2003a.

Runabouts, ski boats, and similar pleasure boats were the most numerous types of watercraft present during all counts, on average comprising 48 percent of watercraft (Table 5.2-4). House boats—primarily beached—comprised the next most common watercraft type counted in this zone, followed by PWCs. Few PWC were observed during the first three counts, but 21 were observed during the final count.

Table 5.2-4. Average number of watercraft and proportion of Lake Oroville use by zone and type during the 2002 and 2003 peak seasons.

	Watercraft Type												ALL TYPES	
	Run-abouts		Personal W'craft		House-boats		Fishing Boats		Pontoon Boats		Non-Motorized			
Lake Zone	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Main Basin	45	47	12	13	20	21	9	9	6	6	4	4	96	100
Middle Fork	66	52	13	10	31	24	8	6	9	7	2	2	128	100
South Fork	43	51	10	12	20	24	7	8	5	6	1	1	85	100
Lower N. Fork	21	57	4	11	5	14	5	14	1	3	1	3	37	100
Upper N. Fork	18	62	2	7	3	10	5	17	1	3	1	3	29	100
West Branch	23	49	6	13	9	19	6	13	1	2	1	2	47	100
All Zones	**216**	**51**	**47**	**11**	**88**	**21**	**40**	**9**	**23**	**5**	**10**	**2**	**424**	**100**

Note: Peak season is Memorial Day weekend through Labor Day weekend. Percentages may not sum to 100 percent due to rounding error. Data include all boats observed on 21 holiday, weekend, and weekday counts.
1. The runabouts type includes ski boats, wake-boarding boats, and cabin cruisers.
Source: EDAW 2003a.

The main basin is the most popular area for sailboats (categorized as non-motorized watercraft), due to the open character of the area and unimpeded winds, though all non-

motorized watercraft represent only about 3 percent of watercraft counted in the zone. The Main Basin also hosted the greatest average number of fishing boats during the peak season, although their numbers were relatively low in all zones. Although good fishing areas exist in the zone, the relatively high number of fishing boats was partly a result of the three boat ramps in the zone.

Middle Fork Zone

Counts on the Middle Fork zone began at the Highway 162 bridge and proceeded upstream. A larger portion of the upper end of the zone becomes shallow and inaccessible to watercraft as the reservoir level drops through the summer. Craig Saddle BIC and floating camps in several coves are the only boating-related facilities in this zone.

On average, 30–32 percent of all watercraft counted lake-wide during the peak season were observed on the Middle Fork, making this zone the most heavily used portion of the lake (Table 5.2-3). Weekend counts during the peak summer months averaged 133 watercraft. On holiday weekends, the average count nearly doubled to 263 boats, with 290 counted on Labor Day 2002 and 289 watercraft counted on the Saturday after Independence Day.

About half of the watercraft observed were runabouts/ski boats. Houseboats were the second most common watercraft type observed on this segment of the reservoir, representing about one fourth of all watercraft using the area. About a third of all houseboats on the reservoir were observed in the Middle Fork, primarily moored along the shore in the several large coves toward the west end of the zone, in particular in Sycamore Creek cove.

South Fork Zone

Counts on this zone began at the mouth of the fork, about one-half mile upstream of the Highway 162 bridge, and proceeded upstream. As is the case with the Middle Fork, the upper end of this zone (beyond the Lumpkin Road bridge) can become mostly dewatered and unnavigable as the lake level drops during the late summer. Enterprise BR and Stringtown Car-top BR are located in this zone as are two of the floating campsites.

On average, 94 watercraft were observed on this zone during the peak season weekend counts, similar to the Main Basin figure of 82 watercraft per count and well above the counts for the three northern zones of the reservoir (Lower North Fork, West Branch, and Upper North Fork). Typically, around 20 percent of all boats observed lake-wide were in this zone (Table 5.2-3), making it the second or third busiest zone during the peak season.

About 50 percent of watercraft observed on this zone were runabouts/ski boats but houseboat use was also substantial, representing about 22 percent of watercraft observed. Houseboats were particularly prevalent on the north shoreline of the large cove just upstream of Craig Saddle.

Lower North Fork Zone

The Lower North Fork zone (referred to locally as "the chute") is a narrow segment extending several miles from the upper main basin to the confluence with the West Branch arm. Several small coves provide boaters shelter along the east shore. Although there are several BICs on this section of the reservoir, there are no boat launches or other boating facilities.

Peak season weekend use on this zone averaged 37 watercraft (Table 5.2-3), though the count reached as high as 82 watercraft on a weekend in June of 2003. Holiday counts averaged nearly 70 boats, while weekday use averaged just 11 boats. This zone typically accounted for less than 10 percent of all boating use during the peak use season.

About 56 percent of the watercraft observed were runabouts/ski boats and nearly 20 percent of watercraft were fishing boats (Table 5.2-4). Houseboats made up about 15 percent of boats, and PWCs were present in similar numbers.

Upper North Fork Zone

The Upper North Fork zone is a narrow arm of the reservoir curving upstream from the confluence with the West Branch for more than 10 miles. There are no developed boating facilities of any kind on this section of the reservoir. There are only a few small coves, and most of the shoreline is too steep for boats to beach or for use by boaters.

The highest count of use in this zone was 49 watercraft, counted during the Independence Day weekend. The average weekend count during the peak season was 32 watercraft (Table 5.2-3). On average, boats on the Upper North Fork zone represented only 7 percent of all boating observed on Lake Oroville, making this the least-used zone of the reservoir.

Over 60 percent of the watercraft observed during each count were runabouts/ski boats, and about 18 percent were fishing boats. Only 3 houseboats were counted in the zone, the fewest of any zone.

West Branch Zone

The West Branch zone extends more than five miles upstream from its confluence with the Upper North Fork arm. Like the Upper North Fork zone, it is narrow and sinuous. However, it contains several long narrow coves, such as those at Dark Canyon and Vinton Gulch. The Lime Saddle Marina occupies a large portion of the middle of the zone, with moored houseboats covering several acres. The Lime Saddle BR is adjacent to the marina. Three of the five car-top boat ramps on the lake are also in this zone.

More than 100 watercraft were observed in this zone on two occasions, and the average was 80 boats during the 3 holiday counts (Table 5.2-3). However, the average

count on peak season weekends was just 48 boats, and weekday counts averaged less than 20 boats. Overall, this zone accounted for about 10 percent of peak-season use.

About 53 percent of the watercraft were runabouts/ski boats. Due to the proximity of the marina and the sheltering coves in this area, an average of about 8 houseboats were active in the area during each count, comprising 18 percent of use.

5.2.1.3 Peak Season Boating Use on Thermalito Forebay, Thermalito Afterbay, and Diversion Pool

A total of 23 counts were conducted on the three water bodies below the Oroville Dam during the peak season. In most instances, the counts were done consecutively on the three reservoirs, one immediately after the other. A few of the 2002 counts did not include the Diversion Pool. In general, peak season boating activity was found to be low on both the Diversion Pool and Thermalito Forebay, while Thermalito Afterbay was found to receive light to moderate amounts of use.

Thermalito Forebay

The 630-acre Thermalito Forebay consists of north and south sections, divided by a bridge crossing a narrow point of the pool. Each section is about 1 to 1.25 miles wide. Boat ramps at the far eastern and southern end of the pool, within the North and South Forebay DUAs respectively, provide access to boaters. Most boat count observations were made with the help of field glasses from the Nelson Avenue bridge, which divides the two sections. Observers also counted boats from the boat ramps on each section as necessary.

Boating use of Thermalito Forebay was light, even during holidays, when an average of 10 boats was observed on the water (Table 5.2-5). The peak count was 14 boats, observed during Labor Day weekend of 2002. Weekend counts ranged from one to eight boats while weekday counts ranged from one to five boats.

Most boats were in active use when counted, but some boats were beached or moored close to shore near the South Forebay DUA, where there is a small swim area. The boat types observed were primarily runabouts and PWC. The reservoir also receives some use by fishing boats and non-motorized boats like small sailboats, sailboards, and canoes. Non-motorized use is concentrated on the North Forebay, where only non-motorized boats are permitted. Larger numbers of sailboats can be found on the North Forebay during organized sailing events.

Thermalito Afterbay

Thermalito Afterbay is about 3.5 miles long, north to south, and about 3.0 miles wide at its widest east to west point, and it covers about 4,300 acres at the maximum pool level. Three boat ramps on the eastern shore provide access for boaters. Boat count observations were made, with the help of field glasses, from the boat ramps as well as the Highway 162 bridge, which crosses the northern portion of the Afterbay.

Boating use of Thermalito Afterbay was light to moderate, though it was greater than use of the Forebay. Counts here were similar to those obtained on the three lower use zones on the north half of Lake Oroville. An average of 43 boats was observed on the water on holidays (Table 5.2-5). The peak count was 68 boats, observed during Labor Day weekend of 2002. Weekend counts ranged from 12 to 53 boats while weekday counts ranged from 8 to 37 boats.

The boat types observed were primarily runabouts and PWC (in about equal numbers). PWC users congregate at both the Monument Hill and Larkin Road ramps. The reservoir also receives some use by fishing boats, and a lesser number of sailboats and sailboards (Table 5.2-6).

Diversion Pool

The Diversion Pool is a scenic, narrow, and sinuous 320-acre pool covering several miles of the Feather River immediately downstream of Oroville Dam. Roads and trails provide car-top boat ramp access from either shore at the lower end of the pool. Only boats with electric motors and non-motorized boats are permitted. All boats are excluded from the upper mile of the pool, from the spillway to Oroville Dam, and the lower half-mile above the Diversion Pool dam.

The observers' vantage point on Burma Road, above the bend in the Diversion Pool, allowed complete observation downstream toward the Diversion Dam but less complete observation upstream toward Oroville Dam. Boats located more than about one-half mile upstream from the bend might not have been seen.

Boating use was observed to be very light on the Diversion Pool, with no boats observed during most count observations. A maximum of 2 boats were observed during several of the holiday and weekend counts. Due to the exclusion of power boats, nearly all boats observed were canoes or kayaks. A few appeared to be small fishing boats with electric motors (these motors tend to be low-power).

Table 5.2-5. Peak season counts of watercraft on Thermalito Forebay, Thermalito Afterbay, and Diversion Pool.

	Count Date	Thermalito Forebay		Thermalito Afterbay		Diversion Pool	
		Active Boats	Total Boats	Active Boats	Total Boats	Active Boats	Total Boats
Holidays	5/27/2002	11	13	No data	No data	2	2
	7/4/2002	6	10	31	36	No data	No data
	9/1/2002	8	14	34	68	0	0
	5/25/2003	8	8	21	26	2	2
	7/5/2003	2	3	25	42	0	0
	Average	**7**	**10**	**29**	**43**	**1**	**1**
Weekends	6/15/2002	5	5	11	12	0	0
	6/22/2002	4	6	12	12	No data	No data
	7/13/2002	6	6	17	17	No data	No data
	8/11/2002	3	3	28	39	0	0
	6/1/2003	3	4	29	53	0	0
	6/15/2003	2	4	28	53	0	0
	6/28/2003	7	8	26	50	1	1
	7/20/2003	5	7	23	40	0	0
	7/26/2003	2	2	30	44	0	1
	8/3/2003	4	6	32	50	0	0
	8/16/2003	2	3	26	46	0	0
	8/24/2003	0	1	20	33	2	2
	Average	**4**	**5**	**23**	**36**	**<1**	**<1**
Weekdays	6/12/2003	4	5	5	8	1	1
	6/18/2003	1	1	18	26	1	1
	7/8/2003	3	4	22	37	1	1
	7/22/2003	3	3	19	28	0	0
	8/12/2003	1	1	14	23	0	0
	8/20/2003	4	4	15	26	0	0
	Average	**3**	**3**	**16**	**25**	**<1**	**<1**

Note: Peak season is Memorial Day weekend through Labor Day weekend.
Source: EDAW 2003a.

Table 5.2-6. Average number of watercraft and proportion by type during the 2002 and 2003 peak seasons.

	Watercraft Type												ALL TYPES	
	Run-Abouts[1]		Personal W'craft		House-boats		Fishing Boats		Pontoon Boats		Non-Motorized			
Lake Zone	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Th. Forebay	1	13	2	32	--	--	1	14	1	12	2	29	5	100
Th. Afterbay	14	38	15	41	--	--	6	15	1	4	1	3	36	100
Div. Pool	--	--	--	--	--	--	1	45	--	--	1	55	1	100

Note: Data include all boats observed during the 23 peak season holiday, weekend, and weekday counts. A dashed line means no boats of that type were observed. Average counts and percentages less than one were rounded up to one.
1. The runabouts type includes ski boats, wake-boarding boats, and cabin cruisers.
Source: EDAW 2003a.

5.2.1.4 Aerial Photography Boat Counts

In addition to conducting boat counts from the surface of Lake Oroville, boat use was also estimated using aerial photography. On two occasions, the reservoir was flown over and aerial photographs were taken of the area. Boats were then counted from the resulting photographs. Boat counts were conducted at about the same time from the water. Flyovers have the potential advantage of covering the entire reservoir in a much shorter period of time than was possible with the on-water method, and may produce a more accurate assessment of boats on the reservoir at one time. However, types of boats on the water cannot be discerned from the aerial photographs.

Results of the flyovers are shown by zone in Table 5.2-7, along with the total lake-wide count from the on-water counts that occurred the same day. On the first count date, which was on the Sunday of Memorial Day weekend (one of the highest recreation use days at Lake Oroville each year), counts derived from the aerial photographs were higher by 160 boats than those derived from the on-water observations. This corresponds to a 24 percent higher count, and suggests that the amount of traffic may be underestimated by the on-water method when boating activity is very heavy (i.e., on a holiday).

Table 5.2-7. Lake Oroville aerial boat counts.

Count Zone	Count Date	
	5/25/2003	**6/28/2003**
West Branch	101	145
Upper North Fork	53	44
Lower North Fork	65	61
Main Basin	274	181
Middle Fork	208	173
South Fork	135	82
Total	**836**	**686**
Total count from on-water observations	672	664
Count difference (aerial - on-water)	+164	+22
Percentage difference (difference/on-water)	+24%	+3%

Source: EDAW 2003a.

However, the large apparent rate of error for the May 25, 2003 on-water counts can be attributed in part to that being the first attempt to conduct observations on the entire lake simultaneous to the flyover. Some of the additional boat drivers and observers who assisted with this special effort were participating for the first time. Complete and accurate observations were obtained, but observations on some zones took much longer than planned. The result was that observations in some areas occurred late in the afternoon, after boating activity would have been expected to have decreased from the mid-afternoon peak. The observations on June 28, 2003 benefited from an additional boat assisting with observations in popular coves, and the experience gained from the May 25 effort.

Comparison of the aerial photograph and on-water counts for the June 28, 2003 count, when boating activity appears to have been about 20 percent lower than on May 25, indicates a 3 percent undercount with the on-water method. This suggests that the accuracy of the on-water method is good under normal, non-holiday weekend use levels. The additional observation boats on the water for the June 28 count would be expected to provide the greatest level of accuracy.

More generally, there are several possible reasons for undercounting with the on-water method, in particular during holidays. First, the typically very heavy holiday boat traffic makes it more difficult for the observers to accurately track and record all the boats present in some areas. Second, the high number of boats on the shoreline during the holiday weekend increases the likelihood that some boats will be hidden behind other boats on the shore and will not be observed or recorded. Boats moving through the large houseboat mooring fields at the marinas also may not be recorded. In contrast, the aerial photographs allow nearly every boat to be seen clearly due to the overhead vantage point.

However, it is important to recognize that the aerial photography method, like the on-water method, has several potential sources of error. For example, the flight path may result in several minutes passing between photographs of adjacent water areas, providing the opportunity for moving boats to appear in more than one photograph and to be double-counted or, conversely, to be missed entirely. Also, deriving the count from the photographs may present some challenges. Sunlight reflections off the water and shadows from surrounding hills and shoreline trees may obscure boats in the photographs. It should also be noted that the aerial photographs do not provide an instantaneous “snapshot” of boating use because a significant amount of time is needed to complete the flyover.

It is difficult to gauge the relative effect of each potential source of error. Our conclusion is that the aerial photography method is likely to result in a small degree of over- or under-estimation of boating activity on Lake Oroville, possibly 5 percent, as compared to an estimated 10 percent with the on-water method. For most purposes, the relatively small improvement in accuracy achieved with aerial photography would probably not justify the much greater cost and the inability to collect boat type data.

Comparison of the aerial and ground-based counts for Thermalito Forebay and Afterbay indicate that the two methods resulted in similar counts of active boats on the water. However, some small boats were difficult to see on the photographs, resulting in lower aerial counts. On Thermalito Forebay, this included small non-motorized boats such as kayaks on the water and PWC on shore. On Thermalito Afterbay, this included PWC on shore near the Monument Hill and Larkin Road ramps.

5.2.2 Non-Peak Season Boating Use

This section describes boating use observed on the Project Area reservoirs during 16 non-peak season observation days; 10 were weekend days, and six were weekdays. During late January, 2003, when the non-peak season observations began, Lake

Oroville water levels were rising quickly but still recovering from the very low conditions of late 2002. The lake elevation on the date the first observations, January 25, was 786 feet; this was 96 feet above the 2002 minimum elevation, but still 114 feet below full pool. The lake elevation was in the moderate range (i.e., between 800 and 850 feet) from early February to mid-April, and was within 8–12 feet of full pool by the time of the last non-peak season observations in mid-May.

5.2.2.1 Non-Peak Season Reservoir-wide Boating Use Levels on Lake Oroville

This discussion of Lake Oroville use levels during the non-peak season begins with a summary of overall use levels and description of that use (active versus inactive boats and boat types). Unlike during the peak-use season, use levels did not vary greatly between zones, and relatively few boats were observed beached or moored on the shoreline. For these reasons, a zone-by-zone discussion is replaced with a more condensed discussion of use across the lake.

Numbers of Boats

Overall, non-peak season use levels were much lower than the peak season. The average weekend count of 94 boats was 22 percent of the peak season average, and the average weekday count of 74 boats was 41 percent of the peak season average (Table 5.2-8). Weekend and weekday boat traffic levels were similar during the non-peak season, with the weekday average just one third lower than the weekend. However, the non-peak season weekend counts varied widely, primarily due to weather differences and the influence of fishing tournaments. A maximum of 145 boats were counted on March 8 and 9, while just 45 boats were observed during the low count, conducted on April 12 and 13. Weekday use levels were more consistent, with most counts ranging between 50 and 75 boats.

Table 5.2-8. Non-peak season counts of watercraft on Lake Oroville (2003).

	Count Date	Lake Oroville Zones												All Zones	
		Main Basin		Middle Fork		South Fork		Lower N. Fork		Upper N. Fork		West Branch			
		Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats	Active Boats	All Boats
Weekends	1/25/03	9	9	10	10	7	7	NA	NA	NA	NA	NA	NA	---	---
	2/1-2/2003	15	15	15	15	13	13	15	15	8	8	14	14	80	80
	2/15-16/2003	18	18	14	14	14	14	13	13	7	7	13	13	79	79
	3/8-9/2003	28	28	25	25	24	24	27	27	19	19	22	22	145	145
	3/22-23/2003	7	7	29	29	26	26	5	5	12	12	19	20	98	99
	4/12-13/2003	11	11	6	6	8	8	5	5	5	5	10	10	45	45
	4/20/2003	11	12	8	9	13	16	12	12	9	9	19	20	72	78
	4/26-27/2003	22	22	29	31	22	22	10	10	8	8	16	16	107	109
	5/4/2003	22	22	21	24	16	21	14	16	14	14	22	22	109	119
	5/17/03	5	8	35	53	29	48	NA	NA	NA	NA	NA	NA	---	---
	Average	**15**	**15**	**19**	**22**	**17**	**20**	**13**	**13**	**10**	**10**	**17**	**17**	**92**	**94**
Weekdays	3/5-6/2003	19	19	15	15	14	14	8	8	8	8	8	8	71	71
	3/18-19/2003	12	12	15	15	12	12	5	5	9	9	13	13	66	66
	4/8-9/2003	8	8	11	11	11	11	7	7	4	4	10	10	51	51
	4/15-16/2003	14	14	12	12	15	15	12	12	8	8	13	13	74	74
	5/6-7/03[a]	NA	NA	23	24	13	15	7	7	10	10	9	9	62	65
	5/13-14/03[a]	NA	NA	27	31	35	41	8	9	9	9	23	26	102	116
	Average	**13**	**13**	**17**	**18**	**17**	**18**	**8**	**8**	**8**	**8**	**13**	**13**	**71**	**74**

Notes: Non-peak season is before Memorial Day weekend and after Labor Day weekend. NA means data are not available for that zone and date, a dash means no Lake Oroville total is listed because data are not available for some zones.
a. Total count most likely underestimates boat traffic by 20-30 boats on these dates since no data are available for the Main Basin zone.
Source: EDAW 2003a.

Boat Types Observed

Observations during the January through mid-May non-peak season of 2003 indicated that very few houseboats, pontoon boats, or PWC use the lake until warmer weather returns in late spring (Table 5.2-9). From 65 to over 80 percent of the boats on each zone were fishing boats (primarily specialized "bass boats") and they were more numerous on most zones during the non-peak season than the peak season (the prime fishing seasons on Lake Oroville are the fall and spring). While fishing boats represented about 9 percent of all watercraft during the peak season (and 7 to 18 percent per zone), during the non-peak season they made up nearly three quarters of all watercraft counted. Most other boats observed were runabouts.

Table 5.2-9. Average number of watercraft and proportion of Lake Oroville use by type during the 2003 non-peak season.

	Watercraft Type												ALL TYPES	
	Run-abouts		Personal W'craft		House Boats		Fishing Boats		Pontoon Boats		Non-Motorized			
Lake Zone	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Main Basin	2	16	1	1	1	7	10	65	1	4	1	8	15	100
Middle Fork	4	18	1	1	2	8	14	68	1	3	1	3	20	100
South Fork	4	20	---	---	1	6	14	71	1	3	1	1	19	100
Lower N. Fork	1	13	1	1	1	3	9	82	1	1	---	---	11	100
Upper N. Fork	2	16	---	---	1	2	8	81	1	1	---	---	9	100
West Branch	2	10	---	---	1	4	13	82	1	1	1	2	15	100
All zones	**14**	**16**	**1**	**1**	**5**	**6**	**66**	**73**	**2**	**2**	**2**	**2**	**90**	**100**

Note: Non-peak season is before Memorial Day weekend and after Labor Day weekend. Data include both active and inactive (beached or moored) in-use boats, observed on 12 weekend and weekday counts. Average counts and percentages of less than 1 percent are rounded up to 1. A dashed line means that no boats of that type were observed. Percentages may not sum to 100 percent due to rounding error.
Source: EDAW 2003a.

Distribution of Boating Use During the Non-Peak Season

The average number of boats counted on each zone during the non-peak season was very similar, with from 10 to 20 boats counted on each zone on weekends, and 7 to 13 boats counted on weekdays (Table 5.2-10). Use tended to be lowest in the Upper North Fork and Lower North Fork zones. The other four zones each accounted for 17 to 20 percent of use on both weekends and weekdays.

Table 5.2-10. Average number of watercraft and proportions of total Lake Oroville watercraft use by lake zone during the 2003 non-peak season.

Count Type	Lake Oroville Zone												ALL ZONES	
	Main Basin		Middle Fork		South Fork		Lower N. Fork		Upper N. Fork		West Branch			
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Weekends	17	18	19	20	18	19	13	14	10	11	17	18	94	100
Weekdays	13	20	13	20	13	20	8	12	7	11	11	17	66	100

Note: Non-peak season is before Memorial Day weekend and after Labor Day weekend. Percentages may not sum to 100 percent due to rounding error. Data do not include 2 weekend and 2 weekday count dates with no data for the Lower North Fork, Upper North Fork, and West Branch zones.
Source: EDAW 2003a.

5.2.2.2 Non-peak Season Boating Use on Thermalito Forebay, Thermalito Afterbay, and Diversion Pool

A total of ten counts were conducted on the three water bodies below the Oroville Dam during the non-peak season: five on weekends and five on weekdays (see Table 5.2-11). In most instances, the counts were done consecutively on the three reservoirs, one immediately after the other. In general, use was very low on all three water bodies during the non-peak season.

Table 5.2-11. Non-peak season counts of watercraft on Thermalito Forebay, Thermalito Afterbay, and Diversion Pool.

	Count Date	Thermalito Forebay		Thermalito Afterbay		Diversion Pool	
		Active Boats	Total Boats	Active Boats	Total Boats	Active Boats	Total Boats
Weekends	2/15/2003	0	0	2	2	0	0
	3/8/2003	3	3	8	11	0	5
	3/22/2003	0	0	1	1	0	0
	4/20/2003	4	4	7	7	0	0
	4/27/2003	2	2	13	18	5	5
	Average	**2**	**2**	**6**	**8**	**1**	**2**
Weekdays	3/6/2003	2	2	1	1	0	0
	3/19/2003	0	0	1	1	0	0
	4/8/2003	2	2	6	6	0	0
	4/15/2003	0	0	3	3	1	1
	5/13/2003	1	1	4	4	0	0
	Average	**1**	**1**	**3**	**3**	**<1**	**<1**

Note: Non-peak season is before Memorial Day weekend and after Labor Day weekend.
Source: EDAW 2003a.

Thermalito Forebay

The highest number of boats on Thermalito Forebay during the non-peak season was 4, and 14 boats were counted during all the counts combined. No boats were present during four of the ten counts. Nearly 60 percent of all of the boats observed during all the counts were fishing boats about 30 percent were non-motorized boats.

Thermalito Afterbay

Use of Thermalito Afterbay was also very low during the non-peak season, with more than 10 boats counted during just two of the 10 counts and just 54 boats counted during all the counts combined. The high count of 18 boats was obtained during late April. Sixty-three percent of boats (34 of 54) were fishing boats. The remainder was about equally divided between runabouts, PWC, and non-motorized boats.

Thermalito Diversion Pool

Similar to the peak-season, very low boating use was observed on the Diversion Pool. During seven of the ten non-peak season counts, no boats were observed, and the maximum count was five boats (counted on two dates). All boats counted were canoes or kayaks, or small non-motorized fishing boats.

5.2.3 Boater Use of Floating Campsites and Boat-in Camps on Lake Oroville

Recreation use at Lake Oroville BICs was low throughout the 12-month data-collection period for this study. For most of that period, the reservoir pool level was too low to provide easy access to campsites from boats. During May and June 2003, water levels were high and provided relatively easy access from the campsites to the water. The occupancy rates of the BICs, as reported from June to September of 2002 and from January to June of 2003, indicate that neither weekend nor weekday usage of the BICs approached capacity during those intervals (Table 5.2-12). BIC usage data were not available for October or November 2002, but the lake level and weather conditions during this time interval indicate that usage of the BICs was probably negligible.

Table 5.2-12. Boat-in Campsite Occupancy, June 2002–June 2003.

Time Period	Weekday Occupancy (percent)	Weekend Occupancy (percent)	Total Occupancy (percent)
Jun-02	0.7	0.5	0.6
Jul-02	0.4	1.8	0.7
Aug-02	0.0	0.1	0.0
Sep-02	0.0	0.0	0.0
Oct-02	N/A	N/A	N/A
Nov-02	N/A	N/A	N/A
Dec-02	0.0	0.0	0.0
Jan-03	0.0	0.0	0.0
Feb-03	0.0	0.0	0.0
Mar-03	0.0	0.0	0.0
Apr-03	0.0	0.0	0.0
May-03	1.6	3.1	2.0
Jun-03	5.6	7.1	6.1
Peak Season	**1.8**	**3.0**	**2.2**
Off Season	**<1**	**0.0**	**0.0**

Note: Data for campsite use during October and November, 2002 were not available.
Source: DPR 2003

The occupancy rates of the Lake Oroville floating campsites, as reported from June to September of 2002 and from January to June of 2003, indicate that weekday and weekend usage of the floating campsites approached capacity in June, July, and August of 2002, as well as during June of 2003 (Table 5.2-13). Floating campsite usage data were also not available for October or November, 2002. However, given the weather conditions during this time interval, usage of the floating campsites can reasonably be expected to have been low. The floating camps were removed from the lake for annual maintenance between December, 2002 and March, 2003.

Table 5.2-13. Floating Campsite Occupancy, June 2002–June 2003.

Time Period	Weekday Occupancy (percent)	Weekend Occupancy (percent)	Total Occupancy (percent)
Jun-02	89.5	94.0	91.0
Jul-02	93.9	92.5	93.6
Aug-02	85.9	90.0	87.1
Sep-02	4.8	28.9	12.0
Oct-02	N/A	N/A	N/A
Nov-02	N/A	N/A	N/A
Dec-02	0.0	0.0	0.0
Jan-03	0.0	0.0	0.0
Feb-03	0.0	0.0	0.0
Mar-03	0.0	0.0	0.0
Apr-03	0.0	0.0	0.0
May-03	35.9	41.1	37.4
Jun-03	86.2	84.4	85.7
Peak Season	**74.1**	**79.2**	**75.6**
Off Season	**1.6**	**1.3**	**1.5**

Source: DPR 2003

5.3 ASSESSMENT OF BOATING INFRASTRUCTURE

Information pertaining to the boating infrastructure provided for public use at the Oroville Project and the condition of those recreation facilities was obtained from Study R-10 – *Recreation Facility Inventory and Condition*. The existing facilities were compared to a set of recently compiled boating facility standards published in the *Ohio Boating Facilities Standards and Guidelines* (Ohio DNR 2003).

5.3.1 Existing Project Area Boating Infrastructure

Table 5.3-1 provides information describing the nine paved boat ramps and associated facilities in the Project Area. Five of the ramps are on Lake Oroville; all but Enterprise BR are considered primary ramps and receive heavy use during the peak boating season. Two of the ramps are on Thermalito Forebay: one is on the South Forebay and one is on the North Forebay, where only non-motorized boating is allowed. There are two additional developed ramps on Thermalito Afterbay. The five car-top boat ramps at Lake Oroville and the one at Thermalito Afterbay are not listed.

Table 5.3-1. Description of Boat Ramps and Associated Facilities.

Boat Ramp	Launching		Toilets		Parking		
	Launch Lanes (Useable Lake Levels)[1]	Floating Docks	Portable/Pit Toilets	Flush Toilets	Car Parking Spaces	Car/trailer parking spaces	Overflow Parking
Lake Oroville							
Spillway BR	Upper ramp: 12 lanes-H Lower ramp: 8 lanes-L to M; 2 lanes-L	3	—	6 (2 ADA)	118 Upper (8 ADA)	Upper ramp: 350 (8 ADA); Lower ramp: 264	—
Bidwell Canyon BR	Upper ramp: 7 lanes-H, 5 lanes-M, 4-2 lanes-L Lower ramp: 3 lanes-L	1	—	8 (2 ADA)	No designated spaces	Upper ramp: 279 (12 ADA); Lower ramp: not marked (unpaved)	Small gravel lot (cars only)
Lime Saddle BR	4 lanes- M to H; 2-3 lanes-L	1	—	4 (all ADA)	45 (3 ADA)	131 (7 ADA)	Approx. 70 car/ trailer spaces
Loafer Creek BR	8 lanes- M to H; 2 lanes-L	1	—	4 (all ADA)	No designated spaces	192 (6 ADA)	—
Enterprise BR	2 lanes- M to H	—	1	—	No designated spaces	40	—
Thermalito Forebay							
North Thermalito Forebay BR (Aquatic Center)	2 ramps (2 lanes and 3 lanes)	2 (1 each ramp)	—	2 (all ADA)	61 (3 ADA)	26 (1 ADA)	—
South Thermalito Forebay BR	2	1	1	—	Not marked (unpaved)	Not marked (unpaved)	—
Thermalito Afterbay							
Monument Hill BR	2	1	—	4	10 (1 ADA)	39 (3 ADA)	Large gravel lot
Wilbur Road BR	2	1	2	—	No designated spaces	14 (1 ADA)	—

1. Lake levels: L = Low, M = Moderate, H = High; high reservoir levels are defined as those above 850 feet, moderate are those from 800 to 850 feet, and low are those below 800 feet.

Note: Several of the boat ramps also have day use amenities such as shaded picnic tables, BBQ grills, drinking water, and telephones. Five of the ramps have fish cleaning stations nearby.

Source: EDAW 2003a.

Most of these are single lane roads ending in the reservoir without docks; pit toilets are the only facilities provided at most sites. Parking is generally on gravel lots or on the roadside.

In addition to boat ramps, Lake Oroville also provides boaters with several primitive BICs, ten floating campsites, and seven floating restrooms. Two marinas provide several hundred long-term mooring buoys, used primarily by houseboats, and a lesser number of covered and uncovered dock slips. The marinas offer fuel, small stores with bait and tackle and other supplies, boat rentals, and pump-out facilities. One marina has a floating restaurant and bar.

5.3.2 General Assessment of Condition of Boating Facilities

In general, boating facilities within the study area are in good condition. There are periodically some exceptions, such as restroom maintenance and trash collection facilities at some boating-related recreation sites. The following boating-related facilities are in generally good condition:

Lake Oroville Boat Ramps
Spillway BR/DUA
Bidwell Canyon BR/DUA
Lime Saddle BR/DUA
Loafer Creek BR/DUA

Other Lake Oroville Facilities
Bloomer Point BIC
Craig Saddle BIC
Goat Ranch BIC
Floating Campsites
Floating Restrooms

Thermalito Afterbay Facilities
Larkin Road Car-top BR
Monument Hill BR/DUA

Table 5.3-2 highlights boating-related recreation facilities that are in need of some maintenance, repair, or replacement. For the most part, the issues are relatively minor, such as providing additional restroom maintenance and signage for car-top boat ramps. One facility, the Lime Saddle Marina, has more substantial needs. The marina was badly damaged by a windstorm in December 2002. The damaged portions of the marina were removed in spring 2003. The marina has operated since that time with reduced dock and mooring capacity and services. Full rehabilitation of the marina is expected to occur after DPR identifies a new concessionaire to operate the marina under a long-term contract. The current concessionaire is operating the marina under a month-to-month contract. Initiation of the process for DPR to enter into a long-term contract with a concessionaire requires approval of the State Legislature. Such approval was given in 2003, but DPR was unsuccessful in negotiating a contract with a

concessionaire, and legislative approval is needed once again to reinitiate the process (pers. comm., Feazel 2004)

Table 5.3-2. Boating-related recreation facilities in need of maintenance, repair, or replacement.

Boating-Related Recreation Site or Area	Maintenance / Repair / Replacement Needed
Afterbay Outlet BR	Boat ramp needs grading or surfacing
Bloomer Cove BIC	Restroom maintenance needed
Bloomer Group BIC	Restroom maintenance needed
Bloomer Knoll BIC	Restroom maintenance needed
Dark Canyon Car-top BR	Trash collection facilities need maintenance Directional sign needs replacement
Enterprise BR	Trash collection facilities need maintenance
Foreman Creek BIC	Restroom maintenance needed
Foreman Creek Car-top BR	Trash collection facilities need maintenance
Lime Saddle Marina	Marina facilities need repair
Nelson Bar Car-top BR	Boat ramp shoulder needs repair
North Thermalito Forebay BR/DUA	Interpretive display needs maintenance
South Thermalito Forebay BR/DUA	Interpretive display needs maintenance
Stringtown Car-top BR	Trash collection facilities need maintenance Boat ramp shoulder needs repair Directional sign needs replacement
Vinton Gulch Car-top BR	Directional sign needs replacement
Wilbur Road BR	Trash collection facilities need maintenance

Source: EDAW 2003a.

5.3.3 Comparison of Project Area Boating Facilities with Standards

Table 5.3-3 presents standards for several specific features of boat ramp facilities. The standards are drawn from the *Ohio Boating Facilities Standards and Guidelines* (Ohio DNR 2003) but are largely based on earlier standards published by the States Organization for Boating Access in the *Design Handbook for Recreational Boating and Fishing Facilities* (SOBA 1996) and intended for nation-wide application. The SOBA standards have been widely recognized as authoritative and applied by the boating industry and many boating management agencies across the United States. The Ohio standards were the most recent and complete set of such published standards known.

The facility inventory data and additional field inspections of the Project Area boat ramps and associated facilities indicate that most of the facilities meet most of the "preferred" standards listed. Specific standards not met by individual facilities include:

Spillway BR

- The three boarding docks provided do not provide a dock on one side of each launch lane. Between docks there are three launch lanes: one on each side with a dock and one in the middle without a dock.
- The three boarding docks, each 75 feet long, do not provide 110 feet of dock for every 100 parking spaces (there are 350 vehicle-trailer spaces in the main lot).

Table 5.3-3. Boat Launching Facility Standards and Guidelines.

Item	Standard/Guideline
Number of vehicle-trailer parking spaces	2-lane ramp: Preferred = 60 spaces Minimum = 30 spaces 4-lane ramp: Preferred = 120 spaces Minimum = 90 spaces 8-lane ramp: Preferred = 240 spaces Minimum = 150 spaces 12-lane ramp: Preferred = 360 spaces Minimum = 240 spaces
Number of single vehicle parking spaces	Preferred: 10% of number of boat trailer spaces Maximum: 20% of number of boat trailer spaces
Accessible parking spaces	76 to 100 total spaces: provide 4 ADA spaces 151 to 200 total spaces: provide 6 ADA spaces 301 to 400 total spaces: provide 8 ADA spaces
Size of vehicle and vehicle-trailer parking spaces	Car spaces: 10 ft. x 20 ft. Car-trailer spaces: 10 ft x 40 ft. (overhangs up to 4ft. acceptable)
Boat ramp slope	Preferred/maximum: 15% Minimum: 12%
Ramp lane width	2 adjacent lanes with dock on one side: 15 feet 3 lanes between floating docks: 15 feet 2 adjacent lanes with docks on each side: 20 feet
Boarding dock placement	On ramps with four lanes or more, should have a dock adjacent to one side of each launch lane
Boarding dock length and width	Preferred length: 110 feet for every 100 parking spaces Preferred width: 6 feet Minimum width: 5 feet
Low water usability	Allow three feet of depth at toe 90% of intended use period; suggest using past 10-year period to establish frequency of usability.
Restrooms	Preferred distance: within 200 ft Minimum number: 1 stall for every 40 parking spaces

Source: Ohio Department of Natural Resources, 2003.

Bidwell Canyon BR

- The single 60-foot boarding dock does not provide the desired length of dock based on the number of parking spaces provided (279 vehicle-trailer spaces).
- The single dock does not provide a boarding dock for each launch lane.
- No designated vehicle-only parking spaces are provided (however, the number of vehicle-trailer parking spaces exceeds the standard, providing some car parking).

Loafer Creek BR

- Does not meet standard for low-water usability during the peak use season (ramp has been usable 67 percent of peak season days between 1990 and 2002; see Section 5.3.4).
- The single 60-foot boarding dock does not provide the desired length of dock based on the number of parking spaces provided (192 vehicle-trailer spaces).
- The single dock does not provide a boarding dock for each launch lane.
- No designated vehicle-only parking spaces are provided.

Enterprise BR

- Does not meet standard for low-water usability during the peak season (ramp has been usable 53 percent of peak season days between 1990 and 2002; see Section 5.3.4 for more detail on this topic).

The asphalt surface of the Spillway and Loafer Creek ramps are not below standard. However, asphalt may lack the required roughness to provide tow vehicles good traction. Concrete ramps finished with V-grooves, as found at the Bidwell Canyon and Lime Saddle ramps are, considered superior to asphalt.

5.3.4 Effects of Low Reservoir Pool Levels on Boat Ramp Access

This section summarizes the effects of low reservoir pool levels on the usability of Project Area boat ramps. Observations of ramp use were made during the 2002 peak boating season and into the fall months of that year. Low pool levels (below 800 feet) existed by mid-July and persisted until February 2003. Additional in-depth information regarding these effects may be obtained in Study R-3 – *Assessment of the Relationship of Project Operations and Recreation*.

5.3.4.1 Effects of Low Reservoir Pool Level on Lake Oroville Boat Ramp Usability During 2002

The Lime Saddle, Bidwell Canyon, and Spillway boat ramps remained usable throughout the peak Memorial Day to Labor Day recreation season in 2002. Each ramp became unusable at some point in the fall, but temporary extensions were put in place by DPR to facilitate their use for bass fishing tournaments. Permanent extensions were subsequently completed at the three ramps when the reservoir was at its lowest elevation in November and early December 2002. The reservoir reached its low elevation for the year on December 12, at about 690 feet.

The Spillway launch facilities provide the best boat access during low pool level periods. The 12-lane upper Spillway launch ramp was unusable by early July 2002. However, the 8-lane paved low-water ramp, directly below the upper ramp, allowed launching until mid-September 2002. The ramp complex includes floating docks and several hundred paved vehicle-trailer parking spaces. A temporary unpaved extension of the low-water ramp made the facility usable into early December, though use of four-wheel-drive vehicles was recommended.

The main Bidwell Canyon BR, with a concrete ramp, seven launch lanes, and a floating courtesy dock, was usable until mid-August. However, the ramp narrows to five lanes near its midpoint. By July, the pool level was near the bottom of the ramp and only two lanes were effectively usable. An adjacent 3-lane low-water ramp was usable until October 20, 2002, when the facility was closed by DPR. A limited amount of unpaved parking is available at the low-water ramp, but some boaters were forced to park some distance away and uphill on the main ramp, or at the parking lot above the main ramp.

Lime Saddle BR does not have a separate low-water ramp like those at the Bidwell Canyon and Spillway areas. Lime Saddle BR was available for general use until about mid-August 2002, with launching possible for boaters with four-wheel-drive vehicles for several additional weeks. The Lime Saddle BR closed in late September, 2002; DWR used the 2002 low-water opportunity to extend it to the 702-foot reservoir level in December, 2002.

The two other developed boat launches on the reservoir became unusable during the 2002 primary boating season. The Loafer Creek BR was closed on July 27, 2002, when the reservoir pool level was approximately 776 feet. The Enterprise BR on the South Fork arm of the reservoir was usable only until early June, down to a reservoir elevation of about 835 feet. However, as late as August 31, 2002, with the pool level at 735 feet, vehicles were observed launching PWCs and other small watercraft from the shoreline near the Enterprise BR.

5.3.4.2 Historic Effects of Low Water on Usability of Lake Oroville Boat Ramps

Historical reservoir elevation data provide the best means to gain some sense of the likely future availability of the ramps during the peak boating season. The assumption made in using the historical data is that the drawdown pattern, particularly minimum summer pool levels, will be similar in the future to what they have been in past years. Faster or lower summer drawdown may result in fewer days of ramp usability.

Peak Boating Season Usability

Focusing on the years from 1990 to 2002, the data summarized in Table 5.3-4 indicate that the Lime Saddle, lower Spillway, and lower Bidwell Canyon ramps would have been closed for part of the peak season due to low water in only one year, 1990. Each ramp would have been closed about one month of the peak season that year, starting in mid-August. The region was in the midst of a several-year drought at that time. At their current lengths, all ramps would have been closed because of low pool levels only about two percent of the peak boating season days over the 13-year period. (The analysis is hypothetical, since the three extended ramps did not actually reach to the stated levels prior to December 2002.)

The 775-foot minimum use elevation for the boat ramp at Loafer Creek BR, the most convenient ramp for boaters camping in the Loafer Creek area, is considerably higher than the other major ramps. Consequently, the ramp was closed about one-third of the peak boating season days. The data further highlight that in those seasons in which the ramp did become unusable, the closure typically extended over more than two-thirds of the peak season (an average of 87 days).

The more remote Enterprise BR is not used as heavily as the other ramps and primarily serves nearby residents. However, because it is usable only down to about the 835-foot elevation, it was unusable for at least part of the summer boating season of each year except those with the highest pool levels (e.g., 1995 and 1996). The ramp was unusable for part of the summer season during 9 of the 13 years examined, and it was unusable for an average of 95 days (most of the season) in those years. The ramp was closed for the entire May 15–September 15 period in 5 of the 13 years. These closures are particularly notable because this is the only primary (not car-top) ramp on the eastern portion of the reservoir, and use of the other ramps requires a much longer drive for local residents.

Table 5.3-4. Lake Oroville boat ramp closures due to low water during the May 15 to September 15 peak boating season (1990–2002).

Boat ramp (listed from lowest to highest minimum usable elevation)	Minimum Usable Elevation	Number of Days Closed	Percent of Days Closed[1]	No. of Years Closed for Part of Season	Average Number of Days Closed[2]
Spillway—lower ramp[3]	695 feet	24	2%	1 of 13	24
Bidwell Canyon—lower ramp[3]	700 feet	30	2%	1 of 13	30
Lime Saddle ramp[3]	702 feet	31	2%	1 of 13	31
Loafer Creek ramp	775 feet	524	33%	6 of 13	87
Enterprise ramp	835 feet	858	53%	9 of 13	95

1. Percentages are based on 1,612 total days: 124 days (May 15–September 15) x 13 years (1990-2002) = 1,612 days.
2. Average includes only those years ramp was unusable (as reported in adjacent column).
3. Data are hypothetical since these ramps did not reach to the stated minimum usable elevations before December 2002, when they were extended to their current elevations.
Source (historic reservoir elevation data): DWR 2003

Non-peak Season Usability

The length of the three lower-reaching ramps becomes more critical to usability during the non-summer months, when reservoir levels are lower. All three ramps are commonly used by bass tournaments and other fishermen, along with a lesser number of pleasure boaters, during the fall, winter, and spring. The full-year pool elevation data for 1990 through 2002 indicate that the reservoir fell below the 702-foot Lime Saddle BR threshold during three periods of time (Table 5.3-5). It further indicates that the reservoir fell below 695 feet, when all ramps would be closed, during two of those three periods.

The lake has typically been at those very low levels for brief periods during the late fall or early winter. The exception was a 222-day period between August 16, 1990 and March 25, 1991. As mentioned previously, the region was in the midst of a several-year drought at that time. The lake was below 695 feet for 209 of the 222 days (the low elevation was 651 feet, reached at the end of January 1991).

Table 5.3-5. Time periods between 1990 and 2002 when Lake Oroville pool elevation fell below current ramp usability thresholds.

Time Period	No. of days below 702 feet[1]	No. of days below 700 feet[2]	No. of days below 695 feet[3]
August 16, 1990 – March 25, 1991	222	220	209
December 7, 1991 – January 10, 1992	15	0	0
November 3, 2002 – December 15, 2002	43	29	9

1. The Lime Saddle boat ramp closes at 702 feet pool elevation.
2. The Bidwell Canyon lower ramp closes at 700 feet pool elevation.
3. The Spillway lower ramp closes at 695 feet pool elevation (all ramps closed).
Source (historic reservoir elevation data): DWR 2003

In summary, year-round reservoir pool level data and field observations show that the Spillway low-water ramp in particular is essential in providing boat launching access during the lowest reservoir elevation periods. The ramp is likely to be usable throughout all or most of the fall and winter months of most years, and provides the most convenient parking to the ramp. The Lime Saddle BR provides boater access to the reservoir through most low-water periods, but with the inconvenience of a long walk up the ramp to the parking lot during low-water periods. The lower ramp at Bidwell Canyon BR also provides access at low pool levels, but with limited parking (overflow parking is above, along one side of the upper ramp lane or in the lot at the top of the upper ramp). These three lowest-reaching boat ramps were not closed because of low pool levels during the nearly 9-year period between early January 1993 and late October 2001. The extensions completed in December 2002 should ensure that closures due to low water levels remain rare.

5.3.4.3 Effect of Reservoir Drawdown on the Number of Lake Oroville Boat Ramp Lanes Available

In addition to effects at individual ramps, the total number of launch lanes available to boaters on Lake Oroville is progressively reduced as the reservoir level falls. This is due both to ramp closures and to the narrowing of most of the primary ramps at lower elevations. A reduced number of lanes available can cause crowding and increase wait times for boat launching and retrieval.

Table 5.3-6 lists the cumulative lane closures that occur, first at the 850 foot elevation and continuing until all ramps are closed at the 695 foot elevation. The most dramatic reductions in lanes available occur between the 820- and 800-foot elevations. At about the 820 foot elevation, the Spillway facility switches from the upper ramp to the lower ramp, with four fewer lanes. At the 800-foot elevation, the Lime Saddle and Bidwell Canyon ramps each lose one lane and the Loafer Creek ramp loses six lanes.

Table 5.3-6. Lake Oroville boat ramp lanes lost during reservoir drawdown due to ramp closures and ramp narrowing.

Pool Elevation reached	Affected Boat Ramp(s)	Net change in number of launch lanes available	Total launch lanes available (lake-wide)
900 - 851 ft.	(Full pool and first 49 feet of drawdown)	---	33
850 ft.	Bidwell Canyon – upper ramp	-2	31
835 ft.	Enterprise launch (closed)	-2	29
820-815 ft.[1]	Spillway - upper ramp (closed, switch to lower ramp)	-4	25
800 ft.	Bidwell Canyon – upper ramp Loafer Creek ramp Lime Saddle ramp	-1 -6 -1	17
780 ft.	Bidwell Canyon – upper ramp	-2	15
775 ft.	Loafer Creek (closed)	-2	13
763 ft.	Lime Saddle ramp	-1	12
745–740 ft.[1]	Bidwell Canyon -- upper ramp (closed, switch to lower ramp)	+1	13
725 ft.	Spillway - lower ramp	-6	7
702 ft.	Lime Saddle ramp (closed)	-2	5
700 ft.	Bidwell Canyon - lower ramp (closed)	-3	2
695 ft.	Spillway - lower ramp (closed)	-2	0

1. The elevations at which the upper and lower ramps at these locations can be used overlap slightly; the switch to the lower ramp will usually occur in the elevation ranges stated.
Source: EDAW 2003a.

5.3.4.4 Summary of Effects of Pool Levels on Primary Lake Oroville Boat Ramps

Overall, boater access to Lake Oroville is good and is not greatly affected by reservoir drawdown to about the 800-foot elevation. An important exception to this is the closure of the Enterprise BR when the pool elevation falls below about 835 feet, which often occurs during the summer. Also, at about the 815 foot pool level, boat launching is switched to the low-water ramp at the Spillway BR, which has four fewer lanes than the upper ramp and which may result in more crowding and longer waits at the ramp during high use periods.

Between 800 and 750 feet, the Bidwell Canyon and Lime Saddle ramps become narrower and the Loafer Creek ramp closes, requiring Loafer Creek campers to go to more distant ramps. Another large effect occurs at 725 feet, when most lanes of the lower Spillway ramp close. Pool elevations below 725 feet do not commonly occur; occasions when they do occur are typically in the fall or winter, after the peak boating season.

5.3.5 Effects of Low Reservoir Pool Levels on Car-top Boat Ramps

Usability of the five car-top boat ramps on Lake Oroville for boat launching varies widely by site. A few are usable for car-top or trailer launching or small boats only when the reservoir pool is within about 50 feet of full pool. Observations indicate that hand launching of car-top watercraft, as well as trailer launching of PWCs and other small boats, is possible from some of the car-top boat launches at reservoir pool levels down to 800 feet. At some locations, hand launching of boats can continue at the low reservoir pool levels typical of the late summer, fall, and early winter seasons (750–800 feet).

5.3.5.1 Vinton Gulch Car-top Boat Ramp

The end of the paved road used for launching at Vinton Gulch is at an elevation of about 850 feet; thus this ramp was unusable for launching throughout 2002, and did not become usable again until mid-April 2003. Hand-launching of small watercraft is possible well below the 850-foot mark, as a gradually-sloping dirt track and footpath continues into the cove beyond the end of the paved road. However, when the pool level was just above the 800-foot elevation, the water was observed to be nearly out of sight of the road and those wishing to hand launch would have to carry their watercraft approximately 1,000 feet to reach the water. As the summer drawdown continued below the 800-foot pool level, the narrow cove dewatered and the shoreline was observed to become increasingly steep and the water much more distant, making hand launching of watercraft difficult.

5.3.5.2 Dark Canyon Car-top Boat Ramp

Similar to Vinton Gulch, the Dark Canyon Car-top BR is located toward the back of a fairly narrow cove. However, here the paved road extends a greater distance along the side of the cove, making the site usable for small-boat trailer launching at lower elevations than at Vinton Gulch. Launching of PWCs was observed as late as August 3, 2002, when reservoir elevation was about 767 feet. However, by mid-August the end of the roadbed ramp was out of the water and some distance above it, with further use blocked by a large rock placed at the end of the ramp. The shoreline alongside and at the end of the access road is very steep, making hand launching of watercraft from the shoreline difficult or impossible.

5.3.5.3 Nelson Bar Car-top Boat Ramp

The roadbed at Nelson Bar is cement down to about 850 feet, and then becomes dirt. A berm prevents vehicles from launching on the roadbed below about 840 feet elevation. The roadbed beyond the berm skirts a steep hillside and has largely eroded away into the cove, rendering it unusable for vehicles. The effects of reservoir drawdown are not severe until the reservoir pool level falls below about 840 feet, beyond which trailer launching of boats is not possible. Hand launching of canoes or kayaks is possible at lower pool levels, but the steep and rocky shoreline is not conducive to that use.

5.3.5.4 Foreman Creek Car-top Boat Ramp

Like the other car-top boat ramps, the main feature at the Foreman Creek facility is an old roadbed used as a ramp to trailer-launch boats. Although it is primarily suited to launching of small fishing boats because of the shallow angle of the roadbed, some standard-sized runabouts were observed launching from the road. Hand launching of boats also occurs on the old road and shoreline. As many as six vehicles with boat trailers were counted in the area at one time (on July 28, 2002), and several PWCs were observed operating from the shore. The roadbed allows trailer launching of boats well below 800 feet elevation.

5.3.5.5 Stringtown Car-top Boat Ramp

The Stringtown Car-top BR on the South Fork of Lake Oroville is at the end of a narrow, winding road terminating at the reservoir. The old roadbed winds around the hilly terrain a considerable distance beyond the high-water line and below the full pool elevation. The road is cement only down to about 870 feet. The length of the old road provides boat access to the reservoir at low reservoir pool levels (down to at least 800 feet).

5.3.6 Effects of Low Pool Levels on Boat-In Campsite Access

Access to the BICs is possible at any reservoir elevation. However, even at pool levels somewhat above 800 feet, as existed through May and June 2002 and the last month of 2003 peak season, campers are faced with a considerable walk up steep shorelines to get from their boats to the campsites. In general, use at these sites is very low when the pool elevation is below 825 feet.

5.4 BOATER PERCEPTIONS AND CHARACTERISTICS

Survey responses provided by boaters are the source of the data used to assess boaters' perceptions about the project reservoirs and other boaters and to characterize boater groups. Recreation visitors in the Project Area were surveyed between May 2002 and May 2003 to ascertain their use of the area, their perceptions of the quality of recreation opportunities, and changes they believe would improve their recreation use. The survey methodology included the Recreation On-Site Survey and a follow-up Mail-Back Survey sent to On-Site respondents who provided a name and address. A portion of the On-Site Survey contained questions directed only to those who were boating during their visit. Additional surveys conducted at similar sites provided (1) information to compare boaters' perceptions at those other reservoirs to boaters' perceptions at Lake Oroville; and (2) information on boaters' (at the similar sites) perceptions of Lake Oroville.

5.4.1 Description of Boater Groups and Visits to Oroville Area

Survey respondents were asked to note the number of adults and children in their group (Table 5.4-1). The most commonly reported group size among boating groups was two people, and most groups had five or fewer members. The mean group size was greater than six due to the influence of a small number of very large groups; about 2 percent of groups were larger than 30 people. The median reported group size of four people is a better indicator of typical group size. Most groups were composed of both adults and

children (about 57 percent of groups included one or more children). The typical group included three or four adults and one or two children.

Table 5.4-1. Boater group size and composition, residency, and frequency of visits to Lake Oroville area.

Survey Item	Responses (percent)
Group Size (mean = 6.6, median = 4)	
1-2 people	27.6
3-5 people	33.8
6-10 people	23.1
>10 people	15.5
Group Composition (adults/children)	
Number of adults: median (mean)	3 (4.4)
Number of children: median (mean)	1 (2.2)
County of Residency	
Butte County residents	53.4
Non-Butte County residents	46.6
Frequency of Visits to Lake Oroville Area	
Regular visitor (3 or more visits per year)	71.1
Occasional visitor (1-2 visits per year)	15.0
Infrequent visitor (< 1 visit per year)	4.3
First visit	9.5

Source: EDAW 2003b (Recreation On-Site Survey).

Just over one-half of the boaters who completed the survey were residents of Butte County. A high percentage (71 percent) identified themselves as "regular" visitors, defined on the survey as those who visit the Lake Oroville area three or more time per year. However, nearly 10 percent of the boaters were first-time visitors.

Several survey questions referred to boaters' current visit (the visit they were engaged in when they were surveyed on-site). Although the average length of boaters' visits was over two days, the majority (56 percent) were on 1-day visits (Table 5.4-2). Another 21 percent were on 2–3 day visits (typically over a weekend). Only a small percentage (4.2 percent) were on visits longer than one week.

The approximately 43 percent of boaters who said they were staying overnight in Butte County is consistent with the 44 percent who were on multiple-day visits. Most of the overnight visitors (about 55 percent) were staying at a vehicle campground, primarily at public campgrounds within the Project Area. About 20 percent were staying on a houseboat. Commercial lodging such as motels and bed-and-breakfasts accounted for only about 5 percent of boater's accommodations. More than 15 percent stayed with family or friends or some other non-camping and non-commercial form of lodging.

Table 5.4-2. General description of boater's current visit to the Lake Oroville area.

Survey Item	Percent
Length of current visit (mean = 2.6 days)	
1 day	56.1
2-3 days	21.0
4-7 days	18.7
>7 days	4.2
Stayed overnight in Butte County (not including in own home) on current trip	42.7
Accommodations used for overnight stay	
Vehicle campground	54.8
Houseboat	19.5
Motel	4.5
Boat-in camp	3.3
Floating camp	3.0
Bed and Breakfast	0.6
Other (e.g., stayed with family or friends)	15.1

Source: EDAW 2003b (Recreation On-Site Survey).

5.4.2 Boater Activities and Areas Boated During Current Visit

Survey respondents were asked to indicate what activities they had (or expected to) participated in during the current trip to the Lake Oroville area. The survey booklet contained a list of 42 activities, and boaters could specify others not listed. Nine of these were under the heading of "boating." Other water-related activities included boat fishing, swimming, and camping at a floating campsite.

As shown in Table 5.4-3, 10 of those 12 activities account for most boater activity. Only two activities were participated in by a majority of boaters: swimming (61 percent) and motor boating (55 percent). Substantial percentages also participated in water-skiing and boat fishing, both with about 41 percent participation. About one-quarter indicate they would engage in PWC (jet-ski) riding. Less than 20 percent indicated they would be houseboating during their visit. Because houseboaters had a lower probability of being surveyed than boaters who launched boats from the boat ramps, where survey contacts were made, participation in houseboating is likely underestimated here. Counts of houseboats in use on Lake Oroville, reported in Section 5.2.1.3 of this report, provide a better estimate for this activity.

Visitors were also asked to identify their primary activity for the trip (Table 5.4-3). The results indicate that boaters' top three primary activities were motor boating, water skiing/wake boarding, and boat fishing with 16 to 19 percent listing those activities. Although a high percentage participated in swimming, it was the primary activity of less than 7 percent of boaters. Similarly, PWC use and house boating were activities participated in by a moderately high percentage of boaters, but less than 7 percent considered those to be their primary activity. Overall, these results underscore the nature of boating recreation which is typified by boater's participation in several activities. For example, a typical motor boater may spent the largest part of their time

on the water cruising (their primary activity), and lesser amounts of time wake boarding, swimming, and fishing. Small percentages of boaters listed non-water related activities as their primary activity, including as bank fishing (5.4 percent), relaxation (4.6 percent), tent camping (3.0 percent), RV camping (1.8 percent), and horseback riding (1.1 percent). All other activities were mentioned by less than 1 percent of boaters.

Table 5.4-3. Boaters' water-related activity participation on trip to Lake Oroville Area.

Activity[1]	Activity Participation (percent)[2]	Primary Activity (percent)
Swimming	61.1	6.7
Motor boating	55.3	19.2
Water skiing / wake boarding	41.4	16.0
Boat fishing	41.3	16.8
PWC use	23.6	6.5
House boating	17.2	6.4
Camping at floating campsite	4.9	0.4
Kayaking	4.6	1.3
Canoeing	3.8	0.3
Sailing	2.8	1.3

1. Two additional boating activities appeared on the survey list: rafting and wind surfing. Both were participated in by one percent or less of survey respondents.
2. Multiple responses were allowed.
Source: EDAW 2003b (Recreation On-Site Survey).

Boaters were asked to identify the primary area in which they boated during the current trip. The question referred them to a map depicting zones of Lake Oroville and the downstream reservoirs. As shown in Table 5.4-4, most boaters indicated that they primarily boated on one of the sections of Lake Oroville (most boaters were contacted at Lake Oroville rather than at the downstream reservoirs). Nearly one-third indicated they primarily boated on the main basin, while much lower percentages listed adjacent zones such as the Middle and South Fork zones.

Table 5.4-4. Boaters' primary boating area during current trip.

Reservoir/Reservoir Section	Percent
Lake Oroville	
Main Basin	32.2
South Fork	12.8
Middle Fork	9.6
West Branch	8.9
Upper North Fork	6.2
Lower North Fork	4.8
Below Lake Oroville	
Thermalito Afterbay	15.2
OWA / Feather River	5.7
Thermalito Forebay	3.6
Diversion Pool	1.1

Source: EDAW 2003b (Recreation On-Site Survey).

Although most of the major boating access points are on the main basin, overall boating activity was found to be fairly light on the zone during on-water observations, with much higher activity found on the Middle and South Fork areas (see Section 5.2). Therefore, it is assumed that some boaters did not refer to the lake map and understood "main basin" to mean a larger area of the lake than intended. The counts of boats from the on-water observations are recommended as more reliable indicators of how boating activity is distributed on the Project Area reservoirs.

5.4.3 Watercraft Used by Boaters

Boaters were asked to identify the type of watercraft that they primarily used when visiting the Lake Oroville Area, from five general types. The majority of respondents (about 67%) indicated a runabout, ski boat, or cabin cruiser (listed as a single category on the survey booklet) as the primary type of boat they used (Table 5.4-5). The next most common primary watercraft type was PWC (commonly referred to as jet skis or wave runners), used by 11 percent of respondents. A similar 9 percent of boaters primarily used a house boat, several hundred of which are moored at each of the two marinas on the lake. The 7 percent of "other" types included primarily bass boats and other specialized types of fishing boats, and inflatables.

Respondents who identified a primary watercraft used in the study area were asked about the ownership of that watercraft. A very high percentage of the respondents (approximately 88 percent) indicated that they owned the watercraft, while the remainder either rented a boat or used a friend's or family member's boat. About 17 percent of the respondents stated that they dock or moor their watercraft at the reservoir (i.e., at one of the marinas).

Table 5.4-5. Description of the watercraft boaters primarily use when visiting Oroville facilities.

Survey Item	Percent
Type of watercraft primarily use	
Runabout/Pontoon/Cabin cruiser/Ski Boat	66.9
PWC (jet ski)	11.1
House boat	8.9
Canoe / Kayak	3.8
Sailboat	1.9
Other	7.4
Ownership of primary watercraft	
Own the boat	87.7
Borrowed or passenger on friend or family member's boat*	6.9
Rent a boat	5.4
Use of docking or mooring facilities (at marinas)	
Yes	17.3
No	82.7

** Responses were written descriptions of "other" ownership.*
Source: EDAW 2003b (Recreation On-Site Survey).

5.4.4 Boaters' Use of Project Area Launch Facilities

Table 5.4-6 indicates the boat ramps that respondents to the boating survey had used during the past year. Multiple responses were accepted. As expected, the most popular boat ramps were the large ones located at Lake Oroville, with the ramp at Bidwell Canyon used by the highest percentage (43 percent). The approximately 37 percent who had used the Spillway ramp may have been unusually low because of the construction that was in progress at the site through much of 2002, while parking and other amenities were being rebuilt.

Table 5.4-6. Boat ramps boaters had used during the past 12 months.

Boat Ramp	Percent[1]
Bidwell Canyon	43.1
Spillway	36.7
Lime Saddle	34.8
Loafer Creek	23.3
Monument Hill (Afterbay)	12.4
Larkin Road (Afterbay)	8.4
South Forebay	6.2
North Forebay	6.2
Enterprise	4.6
Foreman Creek Car-Top	4.3
Stringtown Car-Top	4.3
River Launch	3.5
Nelson Bar Car-Top	1.7
Dark Canyon Car-Top	1.6
Diversion Pool	1.2
Vinton Gulch Car-Top	0.9

1. Multiple responses were allowed.
Source: EDAW 2003b (Recreation On-Site Survey).

Boaters were also asked to indicate which ramp they use most frequently. The three major ramps at Lime Saddle, Bidwell Canyon, and Spillway were each mentioned by 21–24 percent of boaters (Table 5.4-7). The ramp on Thermalito Afterbay at Monument Hill, the most popular ramp on the downstream reservoirs, was mentioned by about 6 percent of boaters.

Table 5.4-7. Most frequently used boat ramps.

Boat Ramp	Percent
Lime Saddle	23.7
Bidwell Canyon	23.4
Spillway	21.2
Loafer Creek	10.7
Monument Hill (Afterbay)	5.7

Note: All others ramps each comprised less than 4% of responses.
Source: EDAW 2003b (Recreation On-Site Survey).

5.4.5 Boaters' Perceptions of Unsafe Boating Behavior

Two questions within the boater section of the on-site survey were focused on boaters' perceptions of unsafe boating behavior by others. First, boaters were asked if they personally had experienced (during their current trip) any encounters with others on the water that they felt put themselves at risk. Next, they were asked if they had observed any boating activity that they felt put others at risk. In the first case, if the answer was "yes" the boaters were asked to describe the encounter and where it occurred. In the second case, boaters were asked only to describe the unsafe activity observed.

Slightly less than 10 percent of the respondents stated that they felt they had been put at risk by others while boating during their current trip, while about 14 percent stated that they observed boating activity that they felt put others at risk (Table 5.4-8). There are likely to be differences among boaters in what behaviors they perceive to cause risk to themselves or others. What one boater may perceive to merely be an instance of rudeness of discourteousness, such as a jet ski coming too close while they are sitting in a cove, another boater may perceive to be causing risk.

Table 5.4-8. Boaters' experiences with and observations of unsafe boater behavior.

Survey Question	Yes (percent)	No (percent)
Did you personally experience any encounters with other users on the water that put you at risk?	9.6	90.4
Did you observe any boating activity today that you felt put others at risk?	13.6	86.4

Source: EDAW 2003b (Recreation On-Site Survey).

5.4.5.1 Descriptions of Encounters with and Observations of Unsafe Boating

The encounters boaters described that they believed put them at risk were placed into six broad categories, as listed in Table 5.4-9. About two-thirds of the described encounters fit within three categories, with each category accounting for about 21 percent of responses: encounters with PWC riders (passing too close, jumping wakes, not paying attention to other boats), boats coming too close, and boats not yielding right of way. Additionally, 9 percent of the encounters described related to the perceptions of excessive speed or boaters not obeying posted no-wake areas.

Some encounters did not relate directly to how a boat was operated, but expressed concern about alcohol use, theft, or other behaviors or expressed complaints about boaters not knowing how to safely and efficiently launch or retrieve boats at the ramps. The remainder of those who said they had this type of encounter did not describe the encounter or were not specific enough in their description to allow categorization (a typical example: "Some boaters don't know what they're doing").

Table 5.4-9. Type of encounters boaters experienced that they felt put them at risk.

Type of Encounter	Number of Encounters	Percentage of Total
Encounters with PWC riders	25	21.9
Boats coming too close	24	21.1
Boats not yielding right-of-way / lack of caution at blind corners	23	20.2
Alcohol use / Theft / Other undesirable behavior	11	9.6
Boats traveling too fast / not following speed regulations	10	8.8
Problems at boat ramp	8	7.0
Unspecified / Unclear	13	11.4
Total	**114**	**100.0**

Source: EDAW 2003b (Recreation On-Site Survey).

Boaters' observations of boating activity that they felt put others at risk tended to mention behaviors similar to those just described; therefore, the same response categories are used to summarize them. Once again, behaviors attributed to PWC users were most frequently described, and a similar percentage of responses related to boaters not yielding right of way to other boats (Table 5.4-10). Observations of boats traveling too fast or not obeying speed restrictions were more prominent, accounting for about 15 percent of the behaviors described. About 20 percent did not give a description or were not specific enough to allow categorization.

Table 5.4-10. Types of activities boaters observed that they felt put others at risk.

Type of activity/behavior	Number of Observations	Percentage of Total
Unsafe PWC use	28	18.1
Problems with right-of-way / blind corners	27	17.4
Boats traveling too fast / not following speed regulations	23	14.8
Alcohol Use / Discourteous or dangerous behavior	20	12.9
Boats coming too close	16	10.3
Unsafe / discourteous behavior at boat ramp	9	5.8
Unspecified / Unclear	32	20.6
Total	**155**	**100.0**

Source: EDAW 2003b (Recreation On-Site Survey).

5.4.5.2 Locations Where Boaters Encountered Unsafe Behavior

Survey respondents who stated that they experienced an encounter that put them at risk were asked to identify where they had experienced this encounter, but only slightly more than half (60 of 114) provided specific location information. Seven boaters stated their encounter was near a dock or boat ramp but did not provide the geographic location of the encounter. Other non-specific responses indicate that many of the encounters described were behaviors the boaters had experienced at several locations or that they perceive to be occurring lake-wide.

Table 5.4-11 shows that, among those encounters that were associated with specific locations, the Main Basin of Lake Oroville and Thermalito Afterbay were the most

common locations for the encounters to occur. The lower-use areas of Lake Oroville and downstream accounted for the fewest encounters.

Table 5.4-11. Location of encounters boaters experienced that they felt put them at risk.

Reservoir / Reservoir Zone / River Section	Number of Responses
Lake Oroville	
Main Basin	13
South Fork	9
Middle Fork	6
West Branch	5
Lower North Fork	5
Upper North Fork	3
Downstream Areas	
Thermalito Afterbay	12
OWA (Includes Feather River below SR 162)	5
Thermalito Forebay	1
Feather River (Diversion Pool to SR 162)	1
Diversion Pool	0

Source: EDAW 2003b (Recreation On-Site Survey).

5.4.5.3 Comparison of Perceptions of Unsafe Boater Behavior at Similar Sites

To compare boaters' perceptions of unsafe boater behavior in the Lake Oroville area with other reservoirs in Northern California, visitors at Shasta Lake, Black Butte Reservoir, and Lake Berryessa were asked the same two questions about encounters or behaviors that put them or others at risk (Table 5.4-12). Low percentages of boaters at the three reservoirs stated that they had encounters that they felt put them at risk (7.2 percent) or observed behaviors that put others at risk (10.2 percent). Although these results are slightly lower than for the Oroville Area reservoirs (Table 5.4-8), they suggest that boaters perceive approximately the same amount of these behaviors in the study area as they do at similar reservoirs in Northern California.

Table 5.4-12. Boaters' perceptions of unsafe boater behavior at similar sites[1].

Survey Question	Yes (percent)	No (percent)
Did you personally experience any encounters with other users on the water that put <u>you</u> at risk?	7.2	92.8
Did you observe any boating activity today that you felt put <u>others</u> at risk?	10.2	89.8

1. Shasta Lake, Lake Berryessa, and Black Butte Lake were identified as similar sites. A total of 293 visitors were contacted at these sites, of which 74% were boaters.
Source: EDAW 2003b (Recreation On-Site Survey).

Like Lake Oroville area visitors, respondents to the similar-site survey were asked to identify what type of encounter they perceived to put them at risk. In general, the perceptions of similar-site boaters were similar to boaters at the Lake Oroville area. Encounters with PWC users were the most common type of encounter, although they

comprised a much larger percentage of the total at the similar sites (Table 5.4-13). Similar percentages of boaters as at the Lake Oroville area mentioned other boats coming too close and traveling too fast.

Table 5.4-13. Type of encounters experienced by boaters at similar sites[1] that put them at risk.

Type of Encounter	Number of Encounters	Percentage of Total
Encounters with PWC users	24	47.1
Boats coming too close	9	17.6
Boats traveling too fast / not following speed regulations	6	11.8
Unspecified / Unclear	12	23.5

1. Shasta Lake, Lake Berryessa, and Black Butte Lake were identified as similar sites. A total of 293 visitors were contacted at these sites.
Source: EDAW 2003b (Recreation On-Site Survey).

5.4.6 Perceptions of Problems Related to Boating Use Levels and Interactions

The follow-up mail survey contained a table in which respondents were asked to indicate "how much of a problem" 30 specific items or issues were during their recent visit to the Lake Oroville area. Six of the items related to boating use levels and boaters' interactions with other boaters, and thus complement the data discussed in the preceding sections related to unsafe boater behavior. Respondents were instructed to check "N/A" for an item if it did not apply (for example, the boating related items reported on here would not be of interest to most non-boaters).

Table 5.4-14 summarizes visitors' responses on the six items, from highest to lowest degree of perception that the issue was "a problem" as indicated by the mean score. (The mean scores are based on numerical codes assigned to responses as follows: 1 = not a problem, 2 = a slight problem, 3 = a moderate problem, 4 = a big problem. Thus, a higher mean score indicates a greater perception of a problem.)

Table 5.4-14. Boaters' perceptions of potential user interaction problems.

	Survey Responses				
Item / Issue	Not a problem (percent)	Slight problem (percent)	Moderate problem (percent)	Big problem (percent)	Mean Score[1]
Encounters with PWC	61.9	18.3	10.7	9.1	1.7
Numbers of watercraft	59.6	23.0	13.6	3.8	1.6
Boat speed or wake effects	63.0	21.1	10.7	5.3	1.6
Noise from boats and PWC	67.7	17.4	9.8	5.1	1.5
Encounters between pleasure boaters and boat anglers	74.3	16.3	5.8	3.6	1.4
Encounters between water skiers and others	75.1	16.2	5.8	2.9	1.4

1. Survey responses were coded: 1 = not a problem, 2 = slight problem, 3 = moderate problem, 4 = big problem.
Note: A comparison of peak and non-peak season mean scores revealed no significant differences.
Source: EDAW 2003b (Recreation On-Site Survey).

Overall, concern about these issues was not high, with 60 to 75 percent of respondents indicating the issues were "not a problem" during their visit. Mean scores for each issue were between 1.4 and 1.7, meaning the average opinion was between "not a problem" and "a slight problem." However, approximately 15–20 percent of respondents considered encounters with PWC, the number of watercraft, boat speed or wake effects, and noise from boats and PWC to be moderate or big problems. Encounters with PWC was most frequently identified as a "big problem" (9.1 percent) and also had the highest mean score (1.7).

5.4.7 Perceptions of Reservoir Water Conditions and Potential Hazards

Five additional items in the mail survey table described in the above section related to water conditions. Again, most of these items would be expected to be of interest primarily to boaters, and non-boaters would be expected to check "N/A" for these items.

Table 5.4-15 summarizes visitors' responses on the five items, from highest to lowest degree of perception that the issue was "a problem" as indicated by the mean score. (As before, a higher mean score indicates a greater perception of a problem.) Overall, concern about several of these issues were considerably higher than concerns about user interactions, with over one-third of respondents indicating that exposed land and water level fluctuations were "a big problem" during their visit. Mean scores for these issues, along with the related issue of shallow water at low pool levels, were between 2.4 and 2.6, meaning the average opinion was between "a slight problem" and "a moderate problem." Concern about the other two items, floating debris and water quality, was much lower, with majorities considering them to be "not a problem" and with mean scores below 2.0.

Table 5.4-15. Lake Oroville boaters' perceptions of potential water condition problems.

	Survey Responses				
Item / Issue	**Not a problem (percent)**	**Slight problem (percent)**	**Moderate problem (percent)**	**Big problem (percent)**	**Mean Score[1]**
Exposed land during low water levels	27.3	18.2	19.1	35.4	2.6
Shallow area during low water levels	30.7	21.9	18.7	28.6	2.5
Water level fluctuations	37.5	14.9	13.7	34.0	2.4
Floating debris in the water	50.8	22.7	14.4	12.0	1.9
Quality of water	70.1	18.7	7.5	3.7	1.5

1. Survey responses were coded 1 = not a problem, 2 = slight problem, 3 = moderate problem, 4 = big problem.
Source: EDAW 2003b (Recreation On-Site Survey).

If mean scores for the top three items (those that are directly related to pool levels) are compared based on the elevation of the lake on the day of the survey, it is apparent that concern about these issues increased as the pool level decreased (Table 5.4-16). The lowest level of concern was registered when the pool level was above 850 feet (generally classified for the purpose of the recreation studies as a high pool level). The level of concern increases through moderate pool levels (800 to 850 feet) to the highest level of concern, registered when the lake was at low pool levels (less than 800 feet).

Although the differences in scores are not large, overall perceptions about these items increases from just above "a slight problem" to scores closer to "a moderate problem."

Table 5.4-16. Comparison of Lake Oroville boaters' perceptions of water level issues at different survey date water levels.

	Pool Level on Survey Date		
Item / Issue	**> 850 ft. (mean score)**	**800–850 feet (mean score)**	**< 800 feet (mean score)**
Exposed land during low water levels	2.2	2.5	2.9
Shallow area during low water levels	2.2	2.3	2.7
Water level fluctuations	2.1	2.4	2.6
Floating debris in the water	2.9	1.9	1.7
Quality of water	1.3	1.5	1.5

1. Survey responses were coded 1 = not a problem, 2 = slight problem, 3 = moderate problem, 4 = big problem.
Source: EDAW 2003b (Recreation On-Site Survey).

Scores for the floating debris in the water follow an opposite pattern, where the greatest level of concern is associated with high pool levels. This agrees with observations of the greatest amount of floating debris on the lake during the late spring and early summer of 2003, when the pool levels were highest. Score for quality of water was slightly higher at moderate and low pool levels, but were low at all pool levels, meaning boaters had relatively little concern about water quality.

5.4.8 Boaters' Opinions Regarding Adequacy of Boating Facilities

The Mail-Back Survey contained another table that listed 27 types of facilities for respondents to evaluate. Six of the listed facilities were boating-related. In each case, respondents were asked to indicate if they felt there were too few, about the right number, or too many of the particular type of facility. (As before, respondents could answer "N/A" for items they were uncertain about or about which they had no opinion.)

Table 5.4-17 summarizes boaters' opinions on the six types of facilities, listed in order from highest to lowest percentage of responses stating there are "too few" of that type of facility. Only "docks or temporary moorage" were judged by a majority (about 52 percent) to be too few in number. About 43 percent felt the number of boat-in campsites was not adequate, while about 37 percent felt the number of boat ramps and boat-in gas stations was not sufficient. The lowest perception of need was expressed in relation to marinas, with slightly more than one-third indicating there were too few at present.

Table 5.4-17. Boaters' opinion of the number of boating facilities.

	Responses			
Type of Facility	Too Few (percent)	About Right (percent)	Too Many (percent)	Mean Score[1]
Number of docks or temporary moorage	51.6	47.7	0.7	1.5
Number of boat-in campsites	43.6	54.9	1.5	1.6
Number of boat-in primitive campsites	42.3	55.5	2.2	1.6
Number of boat-in gas stations	37.7	60.5	1.8	1.6
Number of boat ramps	37.1	62.2	0.7	1.6
Number of marinas	34.5	64.5	1.0	1.7

1. Survey responses were coded 1 = too few, 2 = about right, 3 = too many.
Source: EDAW 2003b (Recreation On-Site Survey).

5.4.9 Boaters' Overall Satisfaction with Boating Experience

The final question within the boater section of the on-site visitor survey asked, "Overall, are you satisfied with your boating experience on this trip to the Lake Oroville area?". Those that responded "no" were asked to explain why they weren't satisfied. Nearly 90 percent of boaters expressed satisfaction with their overall boating experience while only 11.3 percent of boaters were dissatisfied (Table 5.5-18). By a wide margin, the most frequent reason given for being dissatisfied was a low reservoir pool level, mentioned by nearly one-half (46.2 percent) of the dissatisfied respondents. Boat ramp and boat launching problems were the second most common reasons, mentioned by 21 percent of dissatisfied respondents. (These responses typically mentioned inexperienced launchers, crowds at the boat ramp, or ramps too short for the existing lake level, all of which may be exacerbated by reduced launch capacity at low lake levels.) Other less common complaints related to perceptions of crowding on the water, water conditions, and inadequate facilities.

Table 5.4-18. Reasons dissatisfied Lake Oroville area boaters were not satisfied with their boating experience.

Survey Item	Percent
Satisfied with overall boating experience?	
Yes	88.7
No	11.3
Reasons for dissatisfaction[1]	
Reservoir level too low	46.2
Boat ramp/launching problems	21.0
Want more or better facilities	11.8
Too crowded on the water	8.4
Water conditions (too choppy, exposed rocks, dirty)	6.7
Parking inadequate	5.9
Problems with marina	4.2
Hazards in the water	2.5
Other reasons	6.7

Note: There were 1191 respondents. Of these, 134 responded that they were not satisfied, and 119 provided reasons.
[1] The percentages are the proportion of those not satisfied who gave a reason in the listed category. Multiple responses were allowed.
Source: EDAW 2003b (Recreation On-Site Survey).

5.5 BOATING CAPACITY

In this section, four different types of carrying capacity are analyzed and a limiting factor is identified for each reservoir and reservoir section within the study area. Capacity for boating may be limited by facility capacity, social capacity, physical/spatial capacity, or ecological capacity. Each of these capacity types is further defined and discussed below.

It is possible to arrive at a range of boating capacities for reservoir management purposes. Management decisions may focus on strong protection of natural resources or user enjoyment, both of which may reduce capacity. Capacities may also be based on maintaining optimum conditions or on a more moderate standard that allows for greater impacts to resources or user enjoyment. In other words, optimal carrying capacity may sometimes exchange higher boating capacity numbers for other benefits. Also, a range of capacities may be calculated for different types of boating settings or experiences, which are largely determined by the physical and social conditions to be maintained. These types of tradeoffs are further discussed below.

5.5.1 Facility Capacity

The amount of boating use that can occur on a water body cannot exceed the capacity of the facilities (marinas, launch ramps) that boaters use to access the water and the size of the reservoir. Boat ramp capacity is ultimately limited by the amount of parking available for boaters' vehicles and boat trailers. Capacity at a ramp is clearly exceeded when no parking is available for arriving boaters. Data are reviewed in this section that

compares parking capacity and occupancy at the four primary Lake Oroville boat ramps, and at paved ramps on Thermalito Forebay and Thermalito Afterbay. Marina capacity may also be limited by available parking, although this may be less of a factor than at ramps, since marina boaters do not need parking for trailers. At Lake Oroville, car-only overflow parking is available near the marinas, and Bidwell Marina boaters may park in a nearby residential area.

Another indicator that boat ramp capacity may be exceeded is long waits to launch, which may occur whether or not parking is at capacity. Whether and how long boaters wait to launch is a function of both the number of launch lanes available and the number of boaters wanting to launch or retrieve a boat at a particular time (boat launching generally peaks between mid-morning and early afternoon, while retrieval of boats from the lake generally peaks in the late afternoon).

Table 5.5-1 describes the number of launch lanes available at each major Lake Oroville boat ramp at different reservoir pool elevations (Enterprise BR is not included due to its limited availability in most seasons and relatively low use.) Section 5.3.4.3 above discussed the effect of reservoir drawdown on the number of launch lanes available lake-wide. The number of lanes available at each ramp and lake-wide decreases as the pool level decreases, particularly below the 800 foot elevation. Thus, low pool elevations during the summer boating season may lead to increased waiting at launch ramps. During the 10 years from 1993 to 2002, there were three years during which the reservoir fell below the 800-foot pool elevation during July or August, and one year during which the reservoir did not reach 800 feet.

Table 5.5-1. Launch lanes available at Lake Oroville primary boat ramps at specific pool elevations.

Boat Ramp	Launch Lanes Available at Different Pool Elevations[1]
Lime Saddle BR	800 - 900 ft.: 4 lanes 763 - 800 ft.: 3 lanes 702 - 763 ft.: 2 lanes
Spillway BR Upper ramp Lower ramp	 815 - 900 ft.: 12 lanes 725 - 815 ft.: 8 lanes 695 - 725 ft.: 2 lanes
Bidwell Canyon BR Upper ramp Lower ramp	 850 - 900 ft.: 7 lanes 800 - 850 ft.: 5 lanes 781 - 800 ft.: 4 lanes 740 - 781 ft.: 2 lanes 700 - 740 ft.: 3 lanes
Loafer Creek BR	800 - 900 ft.: 8 lanes 775 - 800 ft.: 2 lanes

1. Elevations at which ramp lanes are available are approximate; actual elevation at which lanes are opened or closed may vary depending on the date critical pool elevations are reached and on-site management decisions. Factors such as the position of floating docks and mud or debris on the ramp may also affect the number of usable lanes.

Source: EDAW 2003a.

Data are presented below that summarizes boaters' experience with waits at Project area boat ramps, during both the peak and non-peak seasons. This is supplemented with observations of launching and waits at one of the primary Lake Oroville ramps during a holiday weekend peak use period.

Boaters' perceptions of facility capacity are also expressed in their opinions on the adequacy of the number of existing facilities, which may be influenced both by their experience with parking and with lengths of waits at the ramps. The last type of data presented in this section summarize boaters' feelings about the number of existing ramps, comparing responses given by boaters at each of the four primary ramps.

5.5.1.1 Parking Capacity at Project Area Boat Launches

Table 5.5-2 compares the parking capacity at the primary Lake Oroville boat launches and at three of the paved Thermalito Forebay and Afterbay launches with the average and maximum number of vehicles and vehicles with boat trailers observed. Vehicles and vehicles with trailers were counted during visitor use monitoring data collection for Study R-9 – *Existing Recreation Use*. Data were compiled for this analysis from counts conducted on weekend and holiday afternoons during the mid-May to mid-September peak season, which represent the peak use period for the boat launches. Most of the counts occurred during the 2002 season, but one or two counts were also conducted at each site during the end of the year-long data-collection period in May, 2003. A total of 10 counts were completed at the Lime Saddle, Spillway, and Bidwell Canyon boat launches. Only six counts were completed at Loafer Creek boat launch due to the closure of the ramp in mid-July 2002, when the pool level fell below the minimum usable level for that ramp. From 8 to 11 counts were completed at Thermalito Forebay and Afterbay launches.

Lime Saddle BR

At Lime Saddle BR, the average count of 76 vehicles indicates that there were usually more single vehicles present than parking spaces for them. The vehicle-with-trailer counts, however, indicate that there were usually several dozen of those spaces available for vehicles without trailers to use. Parking capacity was exceeded on July 5, 2002 (Friday of the four-day Independence Day holiday weekend) when the maximum counts of 151 vehicles and 168 vehicles with trailers were recorded. This amount was about 100 vehicles and 40 vehicles with trailers above the capacity of the primary parking lot. The excess vehicles and trailers were parked in the overflow lot at the site, which was also full to capacity. Parking is shared with the marina, and boaters whose boats are moored there and their guests are assumed to account for many of the vehicles without trailers.

An aerial photograph taken Saturday, June 28, 2003, indicates the level of occupancy was similar to July 5, 2002 that day, with the overflow lot nearly full. This level of use may be more indicative of peak season weekends when water levels are high.

Table 5.5-2. Lake Oroville boat launch parking capacity and peak season weekend and holiday occupancy.

Boat Ramp	Vehicles[1]				Vehicles-Boat Trailers			
	Cap.	Avg. Count	Max. Count	Avg. Utilization	Cap.	Avg. Count	Max. Count	Avg. Utilization
Lake Oroville								
Lime Saddle BR[2]	45	76	151	169%	131	78	168	60%
Spillway BR[3]	118	33	79	28%	350	100	211	29%
Bidwell Canyon BR[4]	0	65	117	N/A	279	178	315	64%
Loafer Creek BR	0	26	57	N/A	192	72	138	38%
Total (All Ramps)	**163**	**200**	**404**	**123%**	**952**	**428**	**832**	**45%**
North Therm. Forebay BR[5]	61	N/A	N/A	N/A	26	4	11	15%
Wilbur Road BR	0	2	4	N/A	14	8	15	57%
Monument Hill BR[6]	10	21	40	210%	39	24	47	62%

1. *Single vehicles were often observed to park in vehicle-trailer spaces at the ramps, both where no vehicle-only spaces were provided (Bidwell Canyon and Loafer Creek), and where vehicle-only spaces were provided but vehicle/trailer spaces were more convenient.*
2. *The Lime Saddle area has a paved overflow parking area with space for about 70 vehicles with trailers and a lesser number of single vehicles, depending on the number of trailers present. The average and maximum counts include that area.*
3. *The Spillway parking capacity figures presented include only the main parking lot, and so represent a minimum capacity. Additional parking becomes available on the main ramp, up to a maximum of about 75 vehicles with trailers, as the lake level recedes. The low-water ramp (in use at pool elevations below about 815 ft.) has a paved parking lot, with over 250 vehicle/trailer spaces.*
4. *The main ramp at Bidwell Canyon provides spaces for a maximum of 35 vehicles with trailers as the reservoir recedes. The low water ramp (in use at pool elevations below about 740 ft.) has an unpaved parking area with space for about 30 vehicles with trailers.*
5. *Vehicle counts at North Forebay BR are not reported because counts included the entire North Forebay DUA complex and did not differentiate between vehicles parked in the large main lot near the picnic area and beach and those parked in the smaller lot near the boat ramps.*
6. *The Monument Hill BR has a gravel overflow parking area with space for several dozen vehicles and vehicles with trailers. The average and maximum counts include that area, but the gravel area is not included in capacity totals.*

Source: EDAW 2003a.

Spillway Canyon BR

The Spillway BR is the largest ramp on the lake and has the largest number of parking spaces. The vehicle counts indicate that the parking capacity was never exceeded, even during Memorial Day weekend of 2003 when the maximum counts of 79 vehicles and 211 vehicles with trailers were recorded. The reservoir was at full pool on that date and parking capacity was limited to the number of spaces listed in Table 5.5-2. During all of the other counts (all conducted during 2002), additional parking was available on the main ramp and on the low-water ramp lot. On average, less than one third of the parking at Spillway BR was occupied.

Bidwell Canyon BR

The vehicle counts at Bidwell Canyon indicate that there were typically many cars without trailers present in vehicle/trailer spaces, as no vehicle-only spaces are provided. The average count of 178 vehicles with trailers indicates that there were usually unoccupied vehicle/trailer spaces for those vehicles to use.

However, parking capacity was exceeded on all three of the summer holiday weekends of 2002 (Memorial Day, Independence Day, and Labor Day weekends). During the Memorial Day weekend count, the maximum count of 315 vehicles with trailers was recorded, along with 52 single vehicles. During the Independence Day weekend, the maximum count of 117 vehicles was recorded, in addition to 188 vehicles with trailers. During Labor Day weekend, over 230 vehicles with trailers and over 100 single vehicles were counted. On all of these dates it is clear that many vehicle/trailer spaces were occupied by single vehicles.

Similar to Lime Saddle BR, many of the vehicles without trailers likely belonged to houseboaters and others whose boats are berthed at the adjacent Bidwell Marina, or their guests. The marina has 168 vehicle parking spaces at full pool and more become available as the reservoir level recedes, but these are insufficient to support the level of use the facility receives on many weekends and holidays.

No parking occupancy data are available for 2003 summer weekends because the 12-month data-collection period had ended. However, unscheduled observations indicate that visitors were commonly turned away at the Bidwell Canyon kiosk by mid-morning due to lack of parking space. Vehicles turned away could park in the adjacent residential area, while boaters wishing to launch a boat were sent to the Spillway BR. These conditions are probably typical of summers with high pool levels, as existed during 2003.

Loafer Creek BR

Parking space occupancy was found to be well below capacity at Loafer Creek BR during all five of the weekend afternoon counts conducted during the 2002 summer season. However, during the 2003 Memorial Day weekend the facility was at or near its parking capacity when the maximum counts of 138 vehicles with trailers and 57 vehicles were recorded. There are no designated “vehicle-only” spaces in the parking lot; the 57 vehicles would have occupied all or most of the approximately 40 unoccupied vehicle-with-trailer spaces.

North Thermalito Forebay BR

Counts of vehicles specific to the boat ramp area at the North Thermalito Forebay DUA complex are not available because the counts include the parking areas near the picnic ground and beach areas of the complex as well as the lot near the boat ramps. The vehicle parking spaces in the lot near the ramps were often used by non-boating visitors, but overall utilization was observed to be generally low. During the 2002 Independence Day holiday, however, the picnic and swim beach facilities were heavily used and all parking in the complex was occupied.

Utilization of the vehicle-trailer spaces, all of which are in the lot near the boat ramps, was well below capacity. The maximum count of 11 vehicles with trailers (counted on two occasions, both holidays) indicates utilization is well below capacity at peak use times. However, some vehicle-trailer spaces were used by single vehicles at those times due to the large number of non-boating picnickers and swimmers using the area.

Wilbur Road BR

On average, just over half of the available vehicle-trailer parking at the Wilbur Road BR was occupied during the peak season weekend counts. The lot was observed to be full during a Labor Day holiday weekend count. Although there are no designated spaces for single vehicles, a few vehicles were usually present during the counts. Unmarked space is available in the lot for these vehicles.

Monument Hill BR

Although the average of 21 single vehicles counted at Monument Hill at peak use times exceeded the 10 spaces provided, most of those additional vehicles were parked in the large gravel overflow parking area near the paved boat ramp lot. The average count of 24 vehicles with boat trailers indicates that there were usually several unoccupied vehicle-trailer spaces in the paved lot. A maximum of 47 vehicles with trailers were counted on two holiday weekends, when several of those vehicles were parked in the overflow lot. Even at that time, there was room for additional vehicles in the gravel overflow lot.

5.5.1.2 Wait Times to Launch at Boat Launches

Data relating to this indicator come from survey respondents who were asked if they typically have to wait to launch their boat at the boat ramp they use most frequently. A majority of the boaters surveyed who use the Bidwell Canyon ramp most often said they typically have to wait to launch at that ramp, both during the peak season and the non-peak season (Table 5.5-3). The same was true for the Lime Saddle ramp during the peak season. However, wait times were not excessive, averaging between 9 and 11 minutes year-round at both locations. Most respondents said their typical wait time was 5 or 10 minutes, although about 30 percent of the users of the Bidwell Canyon ramp said a 15 to 30 minute wait was typical.

Fewer boaters said they typically had to wait to launch at the Loafer Creek and Spillway ramps than at Bidwell Canyon or Lime Saddle. About 34 percent of users had to wait at Spillway BR during the peak season, and about 41 percent waited during the non-peak season. Increased waiting during the non-peak season is likely a result of a reduction in the number of launch lanes available at lower reservoir levels, and the higher frequency of fishing tournaments, which may have 100 or more boats participating.

Table 5.5-3. Wait times at Project Area boat ramps.

Boat Launches	Typically have to wait to use the ramp[1]		Average length of wait [1]	
	Peak Season (percent)	Non-Peak Season (percent)	Peak Season (minutes)	Non-Peak Season (minutes)
Primary Lake Oroville ramps (all)	47	48	10	10
Bidwell Canyon BR	54	60	11	11
Lime Saddle BR	55	46	9	10
Loafer Creek BR	38	33	11	9
Spillway BR	34	41	9	8
Downstream reservoir ramps[2]				
North Forebay BR	33	40	7	5
South Forebay BR	15	No Data	5	No Data
Monument Hill BR	39	39	10	6

1. Although the survey questions about waiting to launch were not asked in reference to the peak season or non-peak season, the responses are compared here by the season in which the boaters were surveyed with the expectation that they boaters were likely to respond in reference to their recent use of the ramp.

2. No data were available for the Wilbur Road boat ramp.

Source: EDAW 2003b (Recreation On-Site Survey).

The percentages of boaters having to wait were similar at Loafer Creek BR, but the percentage was higher during the peak season. That ramp is primarily used by Loafer Creek campers and receives light use in the non-peak season when camping activity is low. The length of time boaters typically wait was similar to the other ramps, averaging between 8 and 11 minutes year-round. However, about 2 percent of boaters surveyed at Spillway and 32 percent at Loafer Creek indicated that the typical wait time during the peak season was 15 to 30 minutes.

On Thermalito Forebay, about one third of boaters said they typically had to wait at the North Forebay ramp during the peak season, and 40 percent said they had to wait during the non-peak season. Only 15 percent typically had to wait at the South Forebay ramp during the peak season. Too few boaters were contacted during the non-peak season at this location to provide results. Reported wait times at both locations were generally well under 10 minutes year-round. At the Monument Hill BR, the primary ramp on Thermalito Afterbay, slightly less than 40 percent of peak and non-peak season boaters said they typically had to wait. Average wait times were about 10 minutes during the peak season and 6 minutes during the non-peak season. No data were available for the other paved ramp on the Afterbay, the Wilbur Road ramp.

5.5.1.3 Observation of Boat Launching during Holiday Peak Use Period

Boat launching and retrieval was observed at the Spillway BR on Sunday, May 25, 2003 (Memorial Day weekend) from 11:00 a.m. to 12:30 p.m. The purpose of this observation was to determine the typical rate of boat launching and retrieval at a major ramp during peak use (i.e., peak launching capacity) and to observe directly whether boaters had to wait to launch. The time of every boat launching and retrieval during that

period was recorded. Also, every 10 minutes the amount of activity at the ramp was recorded including:

- Number of boats being launched;
- Number of boats being readied for launch;
- Number of boats being retrieved;
- Number of boats waiting at the floating docks; and
- Number of boats waiting in line to launch.

During this observation, the reservoir pool level was near the top of the ramp, and the full width of the ramp was in use, with three floating courtesy docks in place. Boaters' overwhelming tendency to use dock-side lanes reduced the functional number of lanes to six. Boaters appeared to prefer to wait to use the six dockside lanes rather than use the three non-dockside lanes available with no wait.

Throughout the 90 minutes of observation, there was nearly always a boat being retrieved or launched—sometimes several at the same time. There were usually several boats waiting at the courtesy docks (waiting for someone to return after parking or retrieving the tow vehicle and trailer) and as many as 15 boats were at or near the courtesy docks at one time (boats often move a short distance away from the courtesy docks to wait). Generally, a boat was launched at the ramp every 1–3 minutes, and the launch and retrieval rate was about 40 boats per hour. A total of 42 boats were launched and 17 were retrieved during the 90 minutes of observation.

Although there were usually no boats waiting in line to launch, the rate of launching appeared to be near maximum given the flow of traffic, the space needed by boats being prepared for launch, and the boats waiting at the docks. The observation that there was typically little or no wait time to launch supports the overall conclusion that capacity is not typically exceeded at this major boat ramp, even at peak use times.

5.5.1.4 Boaters' Perception of the Need for Additional Boat Ramp Capacity

Survey data on boaters' opinions on the need for more boat ramps provide a fourth source of information related to boating facility capacity that can complement the data discussed above on boat launch parking occupancy and waits to launch. A high percentage of boaters expressing the opinion that more ramps are needed might suggest that launching capacity is being exceeded.

In Section 5.4.6 of this report, survey data were presented that revealed boaters' opinions on the number of several types of existing boating facilities, including boat ramps. Based on survey data from all sites, about 37 percent of respondents felt there were too few ramps while about 67 percent felt there were enough ramps (or too many). However, if the opinions of boaters contacted at the four primary boat ramps are compared, as shown in Table 5.5-4, it is clear that the opinion of the need for more ramps is primarily associated with users of Bidwell Canyon BR and, to a lesser extent,

Lime Saddle BR, where parking capacity was most often exceeded. Nearly twice the percentage of boaters at Bidwell Canyon BR felt more ramps were needed compared to the larger Spillway BR, where parking capacity was never exceeded. Thus it appears that boaters were not necessarily taking a reservoir-wide view when considering the need for more boat ramps, but were responding to parking capacity limits experienced at particular sites.

Table 5.5-4. Boaters' opinion on the number of existing boat ramps.

Location where boater was contacted	Responses			Mean Score[1]
	Too Few (percent)	About Right (percent)	Too Many (percent)	
All locations	37.1	62.2	0.7	1.6
Bidwell Canyon Boat Ramp	58.4	41.6	0.0	1.4
Lime Saddle Boat Ramp	46.8	53.2	0.0	1.5
Spillway Boat Ramp	29.7	70.3	0.0	1.7
Loafer Creek Boat Ramp	28.6	71.4	0.0	1.7

1. Survey responses were given numerical codes as follows: 1 = too few, 2 = about right, 3 = too many.
Source: EDAW 2003b (Recreation On-Site Survey).

5.5.1.5 Summary of Facility Capacity

The overall conclusion regarding boating facility capacity is that boat launch parking capacity is likely to limit boater access to Lake Oroville during peak use times (summer weekends and holidays) at Bidwell Canyon BR and, less frequently, at Lime Saddle BR. An important aspect of parking capacity at these sites is the high number of boat/trailer spaces being occupied by single vehicles. This is a common problem at many reservoirs in the U.S. Both ramps are adjacent to marinas at which several hundred house boats and other watercraft are moored or docked. At peak use times, the existing single-vehicle parking is not sufficient for the number of marina boaters and their guests. As a result, available parking is greatly reduced for boaters wanting to use the boat ramps.

Reservoir-wide, launching capacity is not being exceeded at Lake Oroville. Ample parking was available at all times at Spillway BR. Although a majority of the boaters who most often launch their boats at Bidwell Canyon and Lime Saddle BRs said they typically had to wait to launch, the average length of wait of about 10 minutes was not excessive. Most boaters said they did not typically have to wait to launch at Spillway or Loafer Creek BRs, and observation of launching at Spillway BR during a holiday peak period indicated little waiting was required. Finally, a majority of boaters surveyed consider the number of existing boat ramps to be adequate.

5.5.2 Social Capacity

Social carrying capacity is the maximum amount of recreational use that can occur without impairing visitors' desired experience. The particular focus is on visitors' perceptions of feeling "crowded." For this study, data on boaters' perceptions of crowding are drawn from the boater section of the On-Site Survey. Boaters were asked to indicate how crowded they felt while on the water that day, using the scale below,

where 1 meant "not at all crowded" and 9 meant "extremely crowded" (Heberlein and Shelby 1986).

1	2	3	4	5	6	7	8	9
Not at all Crowded		Slightly Crowded			Moderately Crowded			Extremely Crowded

Using survey information from boaters about where within the Project they primarily boated during their visit, crowding ratings are compared for different areas, with the emphasis on peak season weekends and holidays. Additional information to assess social capacity for boating is drawn from Mail-Back Survey questions that asked boaters whether boat traffic or interactions with other boaters on the water were problems during their visit.

5.5.2.1 Perceptions of Crowding on the Water during Peak Season Weekends

Table 5.5-5 compares boaters' perceptions of crowding on different areas of Lake Oroville and on the downstream reservoirs during peak season weekends (between Memorial Day and Labor Day weekends, not including Independence Day weekend). Responses were grouped based on the area (Figure 4.2-1) boaters said they primarily boated on during their trip. Most respondents rated crowding as low (from 1 to 3) in all areas of Lake Oroville, with the percentage of respondents giving those ratings ranging from 62 to 82 percent. About 24–33 percent rated crowding as moderate (from 4 to 6) in each zone, with the exception of the Lower North Fork zone of Lake Oroville, where only about 12 percent of respondents rated crowding as moderate.

Table 5.5-5. Boaters' on-water crowding ratings—peak season weekend.

Reservoir / Reservoir Zone	Crowding Ratings[1]			Mean Rating
	Low (percent)	Moderate (percent)	High (percent)	
Lake Oroville Zones				
Main Basin	63.7	30.6	5.6	3.1
Lower North Fork	82.4	11.8	5.9	2.9
West Branch	76.5	23.5	0.0	2.7
Upper North Fork	68.2	27.3	4.5	2.9
Middle Fork	61.5	33.3	5.1	3.4
South Fork	63.5	25.0	11.5	3.6
Downstream Reservoirs				
Diversion Pool	100.0	0.0	0.0	1.3
Thermalito Forebay	81.8	18.2	0.0	2.6
Thermalito Afterbay	69.0	24.1	6.9	3.0

1. Low = ratings of 1-3, Moderate = ratings of 4-6, High = ratings of 7-9. Totals may not equal 100 percent due to rounding error.
Source: EDAW 2003b (Recreation On-Site Survey).

High crowding ratings (from 7 to 9) were received from 4.5 to 6 percent of respondents in most zones. No boaters rated crowding in the high range for the West Branch zone, while about 12 percent did so for the South Fork zone of Lake Oroville.

Mean crowding ratings were near 3 ("slightly crowded") for most areas of Lake Oroville. The exception was the South Fork zone, where the mean rating approached 4. Other studies have found that the majority of visitors who reported crowding scores above 4 on the 9-point scale perceived a loss of enjoyment with their recreation experience (Graefe and Holland 1997).

Crowding ratings for Thermalito Afterbay were similar to those for the Lake Oroville zones, as was the mean rating of 3.0. The ratings for the lightly-used Thermalito Forebay and Diversion Pool were lower, with all of the boaters who used the Diversion Pool and 82 percent of those who used Thermalito Forebay rating crowding as low; mean ratings were well below 3.

5.5.2.2 Perceptions of Crowding on the Water During Peak Season Holidays

Table 5.5-6 presents crowding ratings given by boaters contacted during peak season holiday weekends (Memorial Day, Independence Day, and Labor Day Weekends). High use levels during the holidays (typically the highest of the year) lead to the expectation that perceptions of crowding will also be higher. The data bear out this expectation, with most zones showing substantial increases in boaters' perceptions of moderate or high levels of crowding on the water as compared to the peak season non-holiday weekends, and higher mean ratings for all zones. With the exception of the West Branch zone of Lake Oroville, crowding was no longer perceived as low by majorities of boaters surveyed on Lake Oroville, with 28 to 48 percent of respondents rating crowding at 3 ("slightly crowded") or lower on the 9-point scale for each zone of the reservoir.

The percentage of holiday boaters who rated crowding as moderate increased greatly on the South Fork zone (by 34 percent) and the Lower North Fork zone (by 43 percent). (The sample of Lower North Fork zone boaters was 11 boaters). Ratings in the high range increased substantially for three other zones, increasing about 13 percent for the Main Basin, about 19 percent for the West Branch, and about 22 percent for the Upper North Fork. Perceptions of crowding in the Upper and Lower North Fork zones may be associated with the limited number of good shoreline sites at which houseboaters and others can beach or moor, rather than with high traffic levels. The mean rating increased from 1.1 to 1.7 points for most zones. Once again, the highest perception of crowding was for the South Fork zone, with a mean crowding score approaching 5 for holiday boaters.

Table 5.5-6. Boaters' on-water crowding ratings—peak season holiday.

Reservoir/Reservoir Zone	Crowding Ratings[1]			Mean Rating
	Low (percent)	Moderate (percent)	High (percent)	
Lake Oroville Zones				
West Branch[3]	56.3	25.0	18.8	3.8
Upper North Fork[3]	46.7	26.7	26.7	4.5
Lower North Fork[3]	36.4	54.5	9.1	4.6
Main Basin	44.7	36.5	18.8	4.2
Middle Fork	47.8	43.5	8.7	3.8
South Fork	28.1	59.4	12.5	4.7
Downstream Reservoirs				
Diversion Pool	66.7	33.3	0.0	2.3
Thermalito Forebay	75.0	16.7	8.3	2.7
Thermalito Afterbay	55.6	36.1	8.3	3.4

1. Low = ratings of 1-3, Moderate = ratings of 4-6, High = ratings of 7-9. Totals may not equal 100 percent due to rounding error.
2. The samples of holiday boaters who primarily boated on the West Branch, Upper North Fork, and Lower North Fork zones of Lake Oroville are small (16, 15, and 11 individuals, respectively). From 1 to 4 boaters rated crowding in the "high" range for each zone.
Source: EDAW 2003b (Recreation On-Site Survey).

Crowding ratings on holiday weekends were also higher for the reservoirs below Oroville Dam, but large majorities (67 and 75 percent of boaters surveyed) again rated crowding as low on the Diversion Pool and Forebay, and the mean ratings remained below 3. Perceptions of crowding in the moderate range increased 12 percent for the Afterbay, but the mean rating increased by less than half a point.

5.5.2.3 Boaters' Perceptions of Boating Use and Interactions with Other Boaters

Survey data on boaters' opinions of whether the number of watercraft on the water or various types of interactions with other boaters was a problem during their visit provide another means to access social capacity. Section 5.4.5.4 reported boaters' overall perceptions regarding these issues. For the purpose of this analysis, the focus is narrowed to the percentage of boaters who considered these issues to be moderate or big problems (versus not a problem or a slight problem). Also, opinions during the peak and non-peak season are compared.

As shown in Table 5.5-7, encounters with PWC users were perceived to be the greatest problem during both the peak season and non-peak season. However, no more than about one-fifth of boaters considered any of the issues to be a moderate or larger problem at any time of year. Perceptions that these issues were moderate or big problems actually increased during the non-peak season, although the total number of watercraft on the water and the number of pleasure boaters, PWC, and water skiers is generally lower than during the peak season. This may be explained by a greater number of anglers, in particular tournament and sport bass anglers, on the water during the non-peak season. These boaters, and others who favor the non-peak season, may be more sensitive to disturbance by other boaters than typical peak season boaters.

Table 5.5-7. Boaters' perceptions of potential boating-related problems during the peak boating season.

Item / Issue	Response = Moderate or Big Problem[1]	
	Peak Season (percent)	Non-peak Season (percent)
Encounters between PWC users and other users	19.4	21.6
Numbers of watercraft	16.4	20.7
Boat speed or wake effects	14.4	21.1
Noise from boats and PWCs	13.9	18.1
Encounters between pleasure boaters and boat anglers	8.5	13.0
Encounters between water skiers and others	8.1	10.7

1. Survey responses were as follows: Not a problem, A slight problem, A moderate problem, A big problem, and N/A. Calculation of percentages did not include N/A responses.
Source: EDAW 2003b (Recreation On-Site Survey).

5.5.2.4 Summary of Social Capacity

Boaters' primarily low crowding ratings for all of the Lake Oroville zones and the downstream reservoirs during peak season weekends indicate that social capacity is not being exceeded at most times. This conclusion is also supported by the low number of boaters who felt the number of boats on the water, effects of other boats such as noise and wakes, or encounters with other types of boaters were moderate or big problems. The most prominent issue, encounters with PWC users, could be mitigated by increased education or enforcement of regulations. The fact that boat traffic and interactions with other boaters were more often seen as problems during the non-peak season highlights that social capacity issues are not solely related to high use levels but are also affected by the types of visitors present and their preferences.

Use levels may be approaching their social capacity limits during peak season non-holiday weekends in the highest traffic areas, the Middle and South Fork zones of Lake Oroville, where about 37-38 percent of boaters felt crowding to be moderate or high. This conclusion can be stated with greater certainty in relation to peak season holiday weekends, when 52 percent of Middle Fork boaters and 72 percent of South Fork boaters rated on-water crowding in the moderate or high range. A mean crowding rating approaching 5 for the South Fork zone and above 4.5 for two other zones also suggest social capacity limits are being reached in those areas on holiday weekends.

Very low peak season crowding ratings for the reservoirs below Lake Oroville indicate that social capacity is not close to being exceeded on those water bodies. Peak season social conditions on Thermalito Afterbay, however, appear to be similar to the moderately busy portions of Lake Oroville and may be nearer to reaching social capacity limits in areas where the boating activity tends to be concentrated, primarily near the Monument Hill and Larkin Road BRs.

5.5.3 Physical / Spatial Capacity

The concept underlying analysis of physical capacity is that each watercraft on the water requires a certain amount of surface area to operate in a safe and enjoyable manner. Several sources were used to evaluate physical capacity at the Project Area reservoirs.

5.5.3.1 Sources of Information for Evaluation of Physical Capacity

Most applications of physical capacity to boating rely on a traditional "space standards" approach, which has been in use for several decades. In a recent analysis of recreational carrying capacity for Lakes Mead and Mohave in Arizona and Nevada, the National Park Service notes "a wide range of boating space standards have been suggested in the literature, but there is no particular justification or validation for any of them" (NPS 2002). Thus, the justification for application of particular standards has been based on reasonableness, professional judgment related to specific sites, and from experiences with standards applied in similar settings.

Examples of standards applied at Lakes Mead and Mohave (Lake Mead National Recreation Area) and two other western reservoirs are presented in Table 5.5-8. Each is an expression of a minimum standard or threshold for boat traffic density. These standards are intended to apply to open-water boating with unlimited power (i.e., not non-motorized or low-power boats).

Table 5.5-8. Examples of boating space standards applied at other large reservoirs in the western United States.

Reservoir name (surface area at full pool)	Managing Agency & Date of Application	Range for Application of Standard (Setting Type)	Space Standard (acres/boat)
Lake Powell, UT/AZ (162,700 acres)	NPS (1987)[1]	Urban Natural Zones Rural Natural Zones Semi-Primitive Zones	9 9-18 12-125
Lucky Peak Lake, ID (3,019 acres)	COE (1988)[2]	High density range Base range Low density range	5 10 20
Lake Mead and Lake Mohave, NV/AZ (157,900 & 28,260 acres)	NPS (2002)[3]	Urban Natural Zones Rural Natural Zones Semi-Primitive Zones	6.75 9.0 13.5

1. A maximum of 9 acres per boat was applied as an upper density limit for safe boating in all zones of Lake Powell. The overlapping ranges indicated for the Rural Natural and Semi-Primitive zones are based on the use of an "isolation index" (low, moderate, or high isolation) that accounts for how well boaters can avoid the sight and sound of other boaters. No standards were proposed for more urban or primitive classes.

2. The standards developed for Lucky Peak Lake do not use ROS classes. The high, base, and low density standards shown apply to "high power" boating. Different standards were applied for "low power" boating. The middle "base" density was used to calculate an "optimum" capacity for the lake.

*3. In this example, the 9 acres per boat safe boating standard applied at Lake Powell was used as a starting point and applied to the "middle" Rural Natural class. Standards for the other classes were based on a multiplication or division of that standard (e.g., the 13.5 acres/boat standard for the Semi-Primitive zone = 9 * 1.5). Standards for a primitive and an urban zone were calculated but are not shown here.*

Sources: (NPS 1987; NPS 2002; COE 2002).

Two of the three are expressed as a range of capacities for different boating settings. The settings are based on recreation opportunity spectrum (ROS) zoning that typically contains five to seven classes of outdoor recreation boating settings, ranging from primitive (least developed) to urban (most developed).

The ROS concept was developed by the U.S. Forest Service in the 1970s (Clark and Stankey 1979) and has been widely applied by both the Forest Service and the Bureau of Land Management. The basic concept of ROS is that managers can identify and manage for specific attributes of a recreation setting for specific areas or zones, and the recreation activities and experiences supported by the setting. Setting attributes are (1) physical (e.g., level of development, size of the area, character of surrounding landscape), (2) social (e.g., number and types of other recreationists, density of use, visitor behaviors and patterns of use), and (3) managerial (e.g., facilities provided, law enforcement presence, rules and regulations). Areas are classified along a spectrum based on these factors into setting types ranging from "urban" to "primitive."

5.5.3.2 Draft Water Recreation Opportunity Spectrum Settings and Space Standards

Recently, a draft water-oriented version of ROS, termed Water Recreation Opportunity Spectrum or WROS, has been designed. The Draft Users' Guidebook for WROS states that it "is modeled after the ROS system, yet tailored to water resources such as reservoirs…" (Haas et al. 2003). WROS is used here as an additional tool for developing physical or spatial standards.

The overarching goal of WROS is "to provide planners and managers with a framework and procedure for…conserving a spectrum of high quality and diverse water recreation opportunities" (Haas et al. 2003). The guidebook provides generalized descriptions of recreation settings by WROS class and proposed standards for acceptable densities of boat traffic for each class (in the guidebook, these are referred to as "boating capacity coefficients"). Table 5.5-9 displays the six WROS setting descriptions and space standards. The standards are expressed as ranges of densities. Boat traffic densities allowing 10 or fewer acres per boat are deemed acceptable for Urban settings, areas with high levels of development and high amounts of diverse recreation activity. Acceptable traffic densities are progressively lower as the spectrum moves through Suburban and Rural settings. Settings at the Semi-Primitive and Primitive end are to be managed for over one hundred to several thousand acres of water per boat.

Table 5.5-9. WROS setting descriptions and proposed boat traffic density standards.

Setting Type	Description	Standard (acres/boat)
Urban	Limited opportunities to see, hear, or smell the natural resources due to the extensive level of development, human activity, and natural resource modification; Watching and meeting other visitors is expected and socializing with family and friends is important; Diverse range of visitors and activities, including large groups and special events; and Convenience is central and dominant.	1-10
Suburban	Limited or seldom opportunities to see, hear, or smell the natural resources due to the widespread and prevalent level of development, human activity, and natural resource modification; Watching and meeting other visitors is expected and socializing with family and friends is important; Diverse range of visitors and activities; and Convenience is central and dominant.	10-20
Rural Developed	Occasional or periodic opportunities to see, hear, or smell the natural resources due to the common and frequent level of development, human activity, and natural resource modification; Brief periods of solitude are important though the presence of other visitors is expected; Diverse range of visitors and activities; and A moderate level of comfort and convenience is important.	20-50
Rural Natural	Frequent opportunities to see, hear, or smell the natural resources due to the occasional or periodic level of development, human activity, and natural resource modification; A sense of independence and freedom with a moderate level management presence is important; Diverse range of visitors and activities though experiences tend to be more resource-dependent; and Comfort and convenience is not important or expected.	50-110
Semi-Primitive	Widespread and very prevalent opportunities to see, hear, or smell the natural resources due to the seldom or minor level of development, human activity, and natural resource modification; Solitude and lack of contact with other visitors, managers, and management is important; Opportunities for more adventure-based enthusiasts and overnight visitors; and A sense of challenge, adventure, risk, and self-reliance is important.	110-480
Primitive	Extensive opportunities to see, hear, or smell the natural resources due to the rare and very minor level of development, human activity, and natural resource modification; Solitude and the lack of the sight, sound, and smells of others is very important; Opportunities for human powered activities (e.g., canoeing, fly fishing, backpacking, etc); and A sense of solitude, peacefulness, tranquility, challenge, adventure, risk, testing skills, orienteering, and self-reliance is important.	480-3,200

Source: Haas et al., 2003.

A joint pilot project is being conducted by DPR and the Bureau of Reclamation to apply the WROS system to several California reservoirs, including Lake Oroville (pers. comm., Plunkett 2004). Teams of experts classify reservoir zones based on observations conducted from a boat and based on team members' specific knowledge about existing reservoir recreation use. The pilot project results will provide an inventory of reservoir characteristics at individual reservoirs and regionally to support future management. Although results are not yet available to apply to Project area reservoir capacity determination, they are expected to be available in the near future to support boating capacity decisions. Specifically, WROS can assist in meeting a prerequisite for defining recreation carrying capacity for the reservoirs: a clear statement of desired future conditions to be managed for on each reservoir or reservoir zone.

5.5.3.3 Proposed Physical Capacity Standards for the Project Area Reservoirs

Although none of the reservoir examples discussed in Section 5.5.3.1 provide a direct match to conditions on the Project Area reservoirs, they can be used as a starting point for a set of standards to apply for this study. Although Lake Powell, Lake Mead, and Lake Mohave are much larger than Lake Oroville, their Urban Natural, Rural Natural, and Semi-Primitive settings approximate the range of settings found on Lake Oroville and the other Project reservoirs. Ten acres per boat was applied as the "base" standard at Lucky Peak Lake and approximates the 9-acres-per-boat standard applied to parts of Lake Powell, Lake Mead, and Lake Mohave. This appears to be a reasonable minimum standard to apply on the Project Area reservoirs, with boat traffic densities greater than this standard considered to be "very high density" and exceeding capacity.

Similar to the examples, space standards for lower density traffic can be constructed for the Project reservoirs based on a reasonable stepwise progression from the 10 acres per boat starting point. The draft WROS guidelines suggest a range of 20-50 acres per boat for Rural Developed zones, which applies to most of Lake Oroville and to Thermalito Forebay and Afterbay. (As a point of reference, 40 acres is equal to a square one-quarter mile on a side.) The low end of that range, 20 acres per boat, is a lower traffic density than what was applied for similar settings at the example reservoirs but represents a reasonable option for an "optimum" traffic density. It is a more conservative standard than applied at the very heavily used example reservoirs, but less conservative than the 50 acres per boat standard at the high end of the WROS range. The 20 acres per boat standard can demarcate between high and moderate boat traffic density, while the 50 acres per boat standard can demarcate between moderate and low boat traffic density.

This study, then, applies the density classes and ranges for assessing boat traffic density on the Project area reservoirs shown in Table 5.5-10. Zones with traffic densities based on active boats in the high range will be considered to be "approaching capacity," in particular if they are in the lower portion of that range (less than 15 acres per boat). Zones with traffic densities based on active boats in the moderate or low range will be considered to be "below capacity."

Table 5.5-10. Proposed boat traffic density ranges for assessing Project Area reservoir boat traffic density.

Density Classification	Density Range (acres/boat)[1]	Physical Capacity Assessment
Very High Density	<=10.0	Exceeding capacity
High Density	10.1-20.0	Approaching capacity
Moderate Density	20.1-50.0	Below capacity
Low Density	>50.0	Below capacity

1. The standards are intended to be applied only to counts of active boats on the water. Beached or moored boats do not contribute to boat traffic density until they rejoin the active boat traffic.

The standards will be applied across all reservoir zones, rather than individual zones that appear to fit into particular ROS classes, for two reasons. First, much of Lake Oroville and the other Project reservoirs appear to best fit in the "middle" Rural Natural ROS class as applied at Lakes Powell, Mead, and Mohave (NPS did not use the Rural Developed class contained in WROS), and the 10-acres-per-boat standard applies most directly to that ROS class in the examples. Second, the settings of some of the Lake Oroville zones appear to fit into more than one class, thus applying a standard based on one class would be misleading. For example, the downstream portion of the Middle Fork zone, with boat-in campsites, floating restrooms and camp sites, and visible bridges and homes, best fits the Rural Natural class; in comparison, the narrow upstream portion of the zone, with no facilities present and few or no roads or man-made structures visible, best fits the Semi-Primitive class.

5.5.3.4 Boat Traffic Density During the Peak Season

Calculations of the average number of surface water acres available per boat were made for each zone of Lake Oroville and the downstream reservoirs for peak season weekends and holidays. These calculations serve as the primary basis for assessing the physical capacity of the Project area water bodies for boating. A lower acres-per-boat figure equates to a higher boat traffic density. The calculations were based on counts of boats on the water (see Section 5.2) and GIS-produced estimates of surface acres. The acreage estimates accounted for changes in the surface area of each Lake Oroville zone resulting from reservoir pool level changes. Areas occupied by marinas and associated mooring fields were not deducted from the surface acre figures, and boats moored at marinas were not counted.

Boat Traffic Density During Peak Season Weekends

Table 5.5-11 provides the average peak season weekend boat traffic density for each zone of Lake Oroville and the downstream reservoirs. Figure 5.5-1 shows these data overlaid on a map of the Project reservoirs. Density figures based on all boats observed (including boats in use but beached or moored on or near shore) and figures based only on active boats are both reported in order to show the moderating effect of shoreline use on traffic density. In-use but moored or beached boats were essentially parked and were not contributing to boat traffic at the time they were observed, although they could rejoin the active watercraft at any time.

Considering first the boat traffic densities based on all boats observed, the range for Lake Oroville included low traffic density on the Main Basin and Lower North Fork zones, moderate traffic density on the West Branch and Upper North Fork zones, and moderate traffic density on the Middle and South Fork zones. No zones had traffic in the very high range.

Table 5.5-11. Average peak season weekend boat traffic densities for Lake Oroville and downstream Project reservoirs.

Reservoir/Reservoir Zone	All Watercraft		Active Watercraft	
	Average acres/boat	Density Class	Average acres/boat	Density Class
Lake Oroville Zones				
West Branch	32	Moderate	47	Moderate
Upper North Fork	34	Moderate	44	Moderate
Lower North Fork	69	Low	107	Low
Main Basin	69	Low	96	Low
Middle Fork	18	High	44	Moderate
South Fork	23	Moderate	75	Low
Downstream Reservoirs				
Diversion Pool	213	Low	213	Low
Thermalito Forebay	138	Low	176	Low
Thermalito Afterbay	119	Low	187	Low

1. All watercraft means all boats in use, including those moored or beached on or near the shoreline. Boats moored at marinas were not included.
2. Active watercraft means both moving and stationary boats, but does not include beached or moored boats.
Source: EDAW 2003a.

The Project reservoirs below Lake Oroville received much lighter use compared to Lake Oroville, relative to the area of water available. Average weekend counts of less than one boat on the Diversion Pool, five boats on the Forebay, and 36 boats on Thermalito Afterbay meant there were from 119 to 800 acres available per boat on each Project reservoir.

If beached and moored boats are removed from the calculations, the number of acres available per boat increases considerably for most Lake Oroville zones, as shown in the two right-hand columns of the table. The acres available per boat more than doubles for the Middle Fork zone and more than triples for the South Fork zone because a high percentage of the boats observed in those areas were on the shoreline or moored. Averaged across all weekend counts, only 56 percent of the boats observed were active boats (the percentage ranged from 44 to 78 percent). Active boat traffic density was low on the Lower North Fork, Main Basin, and South Fork zones and was moderate on the West Branch, Upper North Fork, and Middle Fork zones.

Figure 5.5-1. Peak season weekend boating traffic densities.

[8.5 x 11 insert]

Active boat traffic density for Thermalito Forebay and Afterbay approached 200 acres per boat, while it exceeded 200 acres per boat on the Diversion Pool. It should be noted that areas of the Diversion Pool from which boats are excluded were not deducted from the surface acre measurement. However, the very low boat use observed would result in low traffic densities, even with this deduction. No boats were observed on the Diversion Pool most count days; these zero counts are not included in the density calculations.

Boat Traffic Density During Peak Season Holidays

Table 5.5-12 displays average boat traffic densities during the peak season holidays (Memorial Day and Independence Day weekend of 2003, and Labor Day weekend of 2002) on Lake Oroville and the downstream Project reservoirs. These dates accounted for the three highest reservoir-wide Lake Oroville boat counts. Figure 5.5-2 shows these data overlaid on a map of the reservoirs.

Table 5.5-12. Average peak season holiday boat traffic densities for Lake Oroville and downstream Project reservoirs.

	All watercraft[1]		Active Watercraft[2]	
Reservoir/Reservoir Zone	Average acres/boat	Density Class	Average acres/boat	Density Class
Lake Oroville Zones				
West Branch	16	High	36	Moderate
Upper North Fork	23	Moderate	37	Moderate
Lower North Fork	34	Moderate	96	Low
Main Basin	30	Moderate	60	Low
Middle Fork	9	Very High	22	Moderate
South Fork	11	High	37	Moderate
Downstream Reservoirs				
Diversion Pool	160	Low	160	Low
Thermalito Forebay	66	Low	90	Low
Thermalito Afterbay	99	Low	150	Low

1. *All watercraft means all boats in use, including those moored or beached on or near the shoreline. Boats moored at marinas were not included.*
2. *Active watercraft means both moving and stationary boats, but does not include beached or moored boats.*

Source: EDAW 2003a.

If all watercraft are included in the calculations (both active boats and in-use but beached or moored boats), average boat traffic densities were high to very high on the West Branch, South Fork, and Middle Fork Zones, ranging from 9 to 16 acres per boat. Average boat traffic densities were moderate, affording 23 to 34 acres per boat, on the Lower North Fork, Upper North Fork, and Main Basin zones of Lake Oroville.

If only active boats are considered (refer to the two columns at the right side of Table 5.5-12), peak season holiday traffic densities were moderate on all Lake Oroville zones with the exception of the Main Basin and Lower North Fork zones, where they were was low. Traffic densities afforded about 37 acres per boat on the West Branch, Upper North Fork, and South Fork zones, and 22 acres per boat on the Middle Fork zone.

Figure 5.5-2. Peak season holiday boating traffic densities.

[8.5 x 11 insert]

As was the case during non-holiday weekends, the much lower boat traffic densities based on active boats for most zones is a result of the large number of houseboats and other watercraft which typically were beached or moored in sheltered coves within the zones. Reservoir-wide, an average of just 40 percent of the boats observed during the three holiday counts were active, while 60 percent were beached or moored.

The reservoirs below Lake Oroville received increased boating use, but use was still light to very light relative to their size during the holiday weekends. The few boats observed on the Diversion Pool had an average of 160 acres per boat to use. Counting all boats, the boating space available on Thermalito Forebay averaged over 60 acres per boat, and on Thermalito Afterbay averaged nearly 100 acres per boat.

5.5.3.5 Summary of Physical Capacity

Based on observed active boat traffic, none of the Lake Oroville reservoir zones appear to have boating use levels that are at or exceeding their physical capacity during the peak season. However, boating use levels on the Middle Fork zone and, to a lesser degree, the South Fork zone, appear to be approaching their capacity at peak use times (summer weekend and holiday afternoons) particularly if most boats are active rather than beached. Although average weekend boat traffic densities on those zones were usually in the "high" range, on several weekends the total boating use allowed 10 or fewer acres per boat (in the "very high" density range). Active boat traffic density (not including beached or moored boats) was between 15 and 23 acres per boat on those dates.

It should be noted that although boat traffic densities for large areas such as the Lake Oroville zones may not approach a physical capacity limit (e.g., less than 10 acres available per boat), boat traffic density may be higher in some limited areas (for example, near major boat access points or popular places for boats to congregate). The high boat traffic areas near marinas and boat ramps typically have boat speed regulations in effect (e.g., marked no-wake zones) and the high level of boat traffic does not in itself indicate a capacity problem. Conversely, high traffic density in areas with unrestricted speed or areas that pose physical restrictions (e.g., narrow arms or coves) may exceed capacity although densities are moderate for the zone as a whole.

Boating activity was well below physical capacity on the Project reservoirs below Lake Oroville. Boat traffic densities on Thermalito Forebay, Thermalito Afterbay, and Diversion Pool were all low throughout the peak season.

5.5.4 Ecological / Resource Capacity

The concept inherent in ecological or resource capacity for boating is that boating activity can have negative effects on natural resources such as water quality, shoreline soils and vegetation, and shoreline wildlife habitat. Ecological capacity is exceeded for an area when an unacceptable level of lasting impacts on these resources occurs. Potential impacts of boating include concentrations of petroleum-based pollutants from boat engines and PWC, significant shoreline erosion from wave action caused by boats and PWC, leakage or dumping of waste from houseboat holding tanks, and effects on

the use of the reservoir and shoreline areas by sensitive or listed birds and other wildlife.

Currently, there are no Project reservoirs or reservoir zones identified as being at or exceeding ecological capacity. Although they are not complete, studies being conducted under the direction of the Environmental Work Group of the Oroville Relicensing Collaborative have provided the primary information for this assessment. Three studies—two focused on water quality and one on terrestrial wildlife resources—have yielded results to assist in the assessment of ecological capacity. These studies are:

- Study W-1 – *Project Effects on Water Quality Designated Beneficial Uses for Surface Waters*;
- Study W-3 – *Recreational Facilities and Operations Effects on Water Quality*; and
- Study T-9 – *Recreation and Wildlife.*

Studies W-1 and W-3 include monitoring of several water quality parameters that may potentially be affected by boating activity, such as turbidity, bacteria, and petroleum byproducts. Preliminary results of summer 2003 monitoring indicated that levels of MTBE, a gasoline additive, were below the primary maximum contaminant level (MCL) of 13 micrograms per liter, set by the California Department of California Health Services (CDHS) to address health concerns related to drinking water supplies, at the Bidwell Canyon and Lime Saddle BRs and Marinas. Levels of MTBE were above the secondary MCL of 5 micrograms per liter standard (set by CDHS to address concerns about taste and odor in drinking water) at the Lime Saddle BR and Marina and the Bidwell Canyon BR on several summer 2003 monitoring dates.

Monitoring for bacteria (coliform, enterococcus, and streptococcus) conducted during summer 2003 near floating restrooms and campsites and boat-in campsites indicated that bacteria levels met CDHS draft guidelines for water quality (Boullion 2003). EPA criteria for enterococcus bacteria for water used for full body contact recreation were also met (USEPA 2002). The Study W-3, Task 1A Interim Report states that DPR inspects houseboat waste disposal plumbing and feels this program is effective in preventing significant deliberate dumping of wastes from houseboats (Boullion 2002). Petroleum byproduct and bacterial monitoring results for other major boat ramps and for open water areas were not available at the time of this writing. Additional information regarding recreational impacts to water quality is expected to be available in late spring 2004.

Study T-9 evaluates wildlife/recreation conflicts for specific species based on recreation use data from Studies R-7 and R-9 and each species' sensitivity to human intrusion and their particular habitat requirements. The Study T-9 Draft Report was not available as of this writing. However, literature reviewed in the Study T-9 Interim Report (Bogener 2003) documented various impacts on waterfowl, raptors, and other birds from motor boating and PWC use. Several of the studies reviewed concluded that shoreline use and nearness of boating activity were particularly important factors in the degree of

wildlife disturbance that occurred. Disturbance during spring and fall breeding and migratory seasons were of greatest concern. Some researchers suggested use of buffer zones or similar restrictions to minimize wildlife disturbance. The report described such measures taken to protect a new bald eagle nest territory on Lake Oroville discovered in 2002, including restriction of boating and shoreline recreation in the vicinity of the nest. This study has documented that boating activity is low on all Project reservoirs during the spring and fall, which would lessen the likelihood of disturbance of birds and other wildlife at those times.

Some ecological impacts were noted at Lake Oroville BICs during field data collection for Study R-11 – *Recreation and Public Use Impact Assessment*. Shoreline erosion was described as moderate at the Bloomer Cove Area BICs, Craig Saddle BIC, and Goat Ranch BIC. Boaters use the shoreline in many other areas, but effects from that use were judged to be minimal in the context of the normal sedimentation and erosion that occurs in the fluctuation zone of the reservoir during the course of the typical annual operation cycle. Much of the reservoir's shoreline is too steep for boaters to use, and many areas are rocky and thus resistant to physical impacts.

Additionally, after reviewing vegetation maps, large portions of the shoreline along the Diversion Pool and Thermalito Afterbay and some portions of Thermalito Forebay were noted as having sensitive vegetation. Many of these areas are important for waterfowl nesting and other wildlife uses. Little shoreline use by boaters was observed to occur at most of these areas. Small areas of sensitive shoreline vegetation also exist in some areas of Lake Oroville. However, the fluctuation zone acts as a buffer between these areas and boaters who use the shoreline except when the reservoir is at or near full pool, and no boater-related impacts have been observed.

5.5.5 Limiting Factors

The purpose of this section of the report is to review the previous results on facility, social, physical-spatial, and ecological capacity and identify which element is likely to act as the limiting factor on boating use at peak use times. No attempt was made to develop a numeric capacity limit (i.e., boats at one time) for each zone for each factor, as has been done at Lake Powell (NPS 1987) and other large reservoirs. The data collected do not permit a direct relationship to be identified between levels of boating activity and the quality of the recreation experience or deterioration of natural resources, as would be required to derive boats-at-one-time limits. For example, the data indicate that perceptions of crowding on the water are low, but it is not possible to state how many boats would cause an unacceptable number of boaters to feel crowded on each zone. Similarly, few serious or widespread ecological impacts were found, and it is not possible to state how many boats would cause ecological impacts to reach an unacceptable level. It is possible to use existing data to estimate the daily launching capacity of each boat ramp, but it is difficult to associate that limit with specific reservoir zones. Therefore, professional judgments based on experience with boating conditions and management at several large reservoirs across the country were used to highlight likely limiting factors.

Table 5.5-13 summarizes the limiting factor (or factors) identified for each reservoir or reservoir zone, and the current capacity rating (below capacity; approaching capacity; at capacity; and exceeding capacity). A level of priority (low, moderate, or high) was also applied to assist in determining whether immediate management attention to address capacity concerns may be necessary in specific areas.

Table 5.5-13. Identified limiting factor and level of priority for reservoirs and reservoir zones.

Reservoir/Reservoir Zone	Identified Limiting Factor	Capacity Rating	Level of Priority
Lake Oroville Zones			
West Branch	Physical-Spatial/ Facility	Approaching	Moderate
Upper North Fork	Social/Facility	Approaching	Moderate
Lower North Fork	Social	Below	Low
Main Basin	Social	Below	Low
Middle Fork	Physical-Spatial	Approaching	Moderate
South Fork	Physical-Spatial/ Social	Approaching	Moderate
Downstream Reservoirs			
Diversion Pool	Social	Below	Moderate
Thermalito Forebay	Ecological	Below	Low
Thermalito Afterbay	Ecological	Below	Moderate

Source: Site visit conducted in October 2003.

5.5.5.1 Limiting Factors for Lake Oroville

This section discusses the limiting factor or factors identified for each zone of Lake Oroville and the rationale for each judgment.

West Branch Zone. The identification of facilities as a capacity limiting factor for this zone is primarily due to the observation that boat launch parking occupancy at Lime Saddle BR is very high (at or near 100 percent) during some peak season weekends and holidays. Many vehicle/trailer spaces are typically occupied by single vehicles, and less convenient overflow parking is often in use. Secondarily, a majority of boaters indicated they typically have to wait to launch at Lime Saddle BR, although most reported wait times of 10 or fewer minutes, which is considered acceptable. High peak season holiday boat traffic density, coupled with the narrow character of much of the zone and the large houseboat mooring field that limits use in the middle of the zone, suggest physical-spatial capacity is also a limiting factor.

Upper North Fork Zone. Both facility and social factors are identified as the limiting factors for this zone. The justification for facilities as a limiting factor related directly to the West Branch zone, as described above, because no facilities exist within the zone itself, and most boaters using the zone most likely access the lake from the West Branch zone. Social capacity is also identified because peak season holiday mean crowding ratings were in the moderate range (traffic density was also moderate). This

likely relates to the narrow character of the zone and the relatively few shoreline areas or sheltered coves that are suitable for boater use.

Lower North Fork Zone. Because use levels are judged to be well below capacity in this zone, identification of a limiting factor is a projection. Social capacity is judged to be the potential limiting factor because crowding ratings were in the moderate range for holiday weekends. Average boat traffic density was also moderate at those times. Like the Upper North Fork zone, perceptions of crowding may be associated with the limited number of areas for boaters to use the shoreline or separate themselves from traffic traveling up and down the long, relatively narrow zone.

Main Basin Zone. Like the Lower North Fork Zone, use is judged to be well below capacity on this zone, so identification of a limiting factor is a projection. This zone is complex in that it contains three of the primary boat ramps on the lake as well as one of the marinas, yet is also the largest zone in surface area with a several-mile wide open-water area and two long, sheltered coves. The large surface area and low traffic levels in areas away from the major boating facilities meant traffic density was low to moderate at all times. Social capacity is identified as the potential limiting factor given that perceptions of crowding were in the moderate range for holiday weekends, and because of the diverse range of boating activity present. Many boaters cross the zone in transit from access points to other destinations, and the zone is the prime use area for sailboats, which operate best in areas without higher levels of fast motorized boat traffic. The openness of the zone and exposure to winds is desired by sailors but reduces use by other types of boaters.

Middle Fork Zone. Physical-spatial capacity is judged to be a limiting factor for this zone. If all boats are considered, boat traffic density during peak season weekends and holidays was high to very high. Increased consideration of beached and moored boats can be justified given that the lower third of the zone contains several of the most suitable and popular coves for houseboaters and others to congregate. It is also one of the most suitable and popular areas for cruising and water skiing/wake boarding because it is fairly wide and more sheltered from wind and choppy waves than the main basin. Conditions on the upstream two-thirds of the zone are quite different, characterized by a scenic narrow and winding channel with steep sides and few coves. Traffic was commonly observed to be quite heavy at the most narrow upper end of the zone, which is a popular cruising and sightseeing destination for boaters.

South Fork Zone. Conditions on the South Fork zone were observed to be similar to those described above for the Middle Fork zone, with a high number of houseboats and others boats using shoreline and coves and cruising boats and water skiers/wake boarders using more open areas. Considering all watercraft, peak season weekend and holiday boat traffic densities were moderate overall but were in the high range on holidays and on some weekend days. Therefore, physical capacity is judged to be a limiting factor here. However, social capacity is also judged to be an additional limiting factor because the highest mean crowding ratings were given for this zone, and the

mean ratings were in or near the moderate range on peak season weekends and holidays.

5.5.5.2 Limiting Factors for Reservoirs Downstream of Lake Oroville

Like some Lake Oroville zones, use levels of all three downstream reservoirs were found to be low and well below any capacity limits. Therefore, identification of limiting factors is a projection into the future rather than an assessment of current limits.

Diversion Pool. For this reservoir, social capacity is considered most likely to limit future boating. The reservoir is reserved for non-powered and electric motored boating only, and is unique within the Project area for the primarily natural, quiet, and low use-density type of experience it offers boaters. Boaters using the reservoir expect and enjoy the low use levels that exist. However, this use could probably increase significantly above the very low use levels that exist without impairing these experiences.

Thermalito Forebay. Use levels were low on both the non-motorized northern portion of the Forebay, and the motorized boating southern portion of the Forebay. While use levels could increase significantly without approaching physical and social capacity limits, the fact that this water body and several sensitive shoreline areas have special importance for waterfowl implies that ecological capacity is a likely limiting factor. If use levels were to increase significantly, measures might need to be taken to ensure the long-term protection of sensitive waterfowl habitat.

Thermalito Afterbay. Overall use levels were low on the Afterbay, although they were higher in areas closest to the two main boat access points. Like Thermalito Forebay, use levels could increase significantly without approaching physical and social capacity limits. The Afterbay is also important for waterfowl, and includes brood pond areas near the shore. Therefore, ecological capacity is considered the most likely limiting factor. As on Thermalito Forebay, if use levels were to increase significantly, measures could be taken to ensure the long-term protection of sensitive waterfowl habitat.

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6.0 DISCUSSION AND CONCLUSIONS

The objectives of this study are to describe the existing recreational boating infrastructure, boating use, boating conditions, and water surface management on Lake Oroville and the other reservoirs within the study area. Study results are used to assess boating safety, existing condition of boating facilities, existing reservoir boating use levels, and whether existing facilities are adequate given the amount and type of boating use. Additionally, the results help determine if capacity limits for boating are being exceeded on the reservoirs, and if reservoir surface water or recreation management changes are needed relative to recreational boating.

6.1 BOATING SAFETY AND WATER CONDITION ISSUES

State and local agencies with responsibilities for recreational boating safety and law enforcement on the Project described several boating issues as being of special concern. These include boaters exceeding the 5 mph limit in designated zones, unsafe use of personal watercraft, boaters not wearing PFDs, and alcohol use while boating, among others. Data for 1997 through 2002 on boating accidents reported to DBW indicate that the number of accidents at Lake Oroville is not high, averaging less than one per month, but varies considerably from year to year. Sixteen accidents were recorded during 1999, but just four were recorded in 2002. Survey results indicate that relatively few boaters personally observed unsafe boating behavior or had a high level of concern about interactions with other boaters.

Overall, boating conditions appear safe on the Project reservoirs. Nevertheless, the fact that 10 percent of boaters did experience behaviors that they felt put them at risk underscores the concerns of law enforcement personnel and the need for continued attention to boater safety on the water. The presence of patrol boats on the water during the peak season is particularly valuable toward maintaining safe boating conditions.

Boaters' primary concerns regarding water conditions are related to Lake Oroville fluctuations and exposed land and shallow areas at low pool levels. Lake levels below 850 feet, which commonly occur during the peak use season, dewater certain coves popular with houseboaters and others. Lake levels below 800 feet substantially reduce the number of launch lanes available lake-wide, considerably reduce the surface area available for boating, and arguably increase navigation hazards. These concerns are particularly prominent in the study results due to conditions during the 2002 season, when lake levels were below 850 feet during the entirety of the peak boating season and below 800 feet for the last seven weeks of the season. Law enforcement personnel also identified safety issues related to seasonal water level changes at Lake Oroville. DPR maintains buoys marking major underwater obstructions.

Water level fluctuations at Lake Oroville are and will remain a fact of normal operations of the Oroville Facilities. As such, efforts to minimize (to the extent possible) the effects of water level fluctuations on boater access, safety, and enjoyment will likely continue. This specifically includes provision of adequate boat access during low water periods,

marking of underwater hazards, and collection of the floating debris on Lake Oroville that accumulates as the reservoir fills during the spring of each year.

6.2 EXISTING CONDITION OF BOATING FACILITIES

The boat ramps and associated facilities on Lake Oroville and the downstream reservoirs are generally in good condition and meet most established standards for the design of such facilities. Features assessed include number and size of vehicle and vehicle-trailer parking spaces, number of ADA accessible parking spaces, ramp slope and lane width, low water usability, and restrooms. Parking, restrooms, and other amenities were reconstructed during 2002 at the Spillway BR, the largest boat launching facility on the lake.

The Bidwell Canyon and Loafer Creek BRs do not meet standards for single-vehicle parking spaces (no designated regular-sized spaces are provided). The conventional standard recommends a number of vehicle parking spaces equal to 10 percent of the number of vehicle-trailer spaces. At Loafer Creek, there were usually several unoccupied vehicle-trailer spaces, each of which provides space for two cars, with additional unoccupied vehicle-trailer spaces remaining for arriving boaters. Parking is more problematic at Bidwell Canyon. Vehicles parked in vehicle-trailer spaces contributed to the frequent turning away of boaters from the site during peak season weekends due to lack of parking. Boaters who are turned away at Bidwell would most likely go to the Spillway ramp, about two miles away, which has ample parking.

The other standard not met at several major boat ramps is for the number and length of floating boarding docks. Although the Spillway ramp does not meet the standard, the current amount of use of the ramp did not appear to cause the existing three docks to be severely inadequate. However, the single docks at Bidwell Canyon and Loafer Creek are in high demand, and often make launching and retrieval more difficult and reduce launch and retrieval efficiency.

The Spillway, Lime Saddle, and Bidwell Canyon BRs meet the standard for low-water usability during both the peak boating season (Memorial Day weekend through Labor Day weekend) and the non-peak season. The standard suggests that the ramp should be usable 90 percent of days over the previous 10 years for the season of interest. Each of those ramps was extended by DWR in December 2002 and will provide boaters access to the water year-round most years.

The Loafer Creek and Enterprise BRs do not reach as low and do not meet the standard as applied to the peak season, having been usable 67 and 47 percent, respectively, of peak season days over the last 10 years. While launch opportunities are still provided relatively nearby when the Loafer Creek BR is dry (at Bidwell Canyon or Spillway), boaters wishing to launch on the east side of the lake (Middle Fork and South Fork arms) often do not have a developed ramp readily available. This suggests that special consideration should be given to extending the ramp (thus the use season) at Enterprise or providing new access in the area.

6.3 EXISTING BOATING USE LEVELS

Counts of boats on the Project Area reservoirs were conducted during the 2002 and 2003 peak boating seasons, and the late winter and spring portion of the 2003 non-peak season. Lake levels were low much of the 2002 peak season, but were high to moderate the entire 2003 peak season. The counts indicated that boating use levels are relatively light on Lake Oroville given the size of reservoir.

The highest use levels were observed on peak season holiday weekends when approximately 700 to 1,050 boats were in use on the water. Because a high percentage of these were beached or moored on or near shore, the density of boat traffic was much less than if most boats were active. The Middle and South Fork zones generally receive the greatest amount of boating use, both in terms of numbers of boats and boat traffic density. The types of boats using the lake are diverse during the peak season, with runabouts/ski boats and houseboats most prominent.

Non-peak season use was much lower on Lake Oroville, averaging about one-quarter to one-third of peak season use levels. Fishing boats are the dominant boat type during the non-peak season.

Use levels can be characterized as low on the Diversion Pool, Thermalito Forebay, and Thermalito Afterbay during both the peak season and non-peak season.

No specific conclusions or recommendations are offered in relation to current use levels, which are moderate in most areas at most times during the summer peak boating season. However, the importance of accurate information for future planning suggests that periodic monitoring of the amount, type, and distribution of boating activity on the project reservoir would be useful.

6.4 CARRYING CAPACITY

Due to the diversity of boating use, the wide range of boating conditions at various locations and time of year, and the complexity of physical, facility, social and ecological factors, no attempt was made to calculate a maximum boating use limit (boats at one time) for Lake Oroville or the downstream reservoirs. Rather, this study determined whether current use levels and character of use appear to be approaching or exceeding acceptable levels based on physical/spatial, facility, social, and ecological criteria.

In general, boating capacity does not currently appear to be a significant issue on the Project Area reservoirs. The highest use sections of Lake Oroville may be approaching social and spatial capacity during peak use times, but this appears largely to be a function of preferred shoreline mooring locations filling up rather than conflicts with active boat traffic. Facility capacity limits may be limiting use of the two northernmost arms of the lake, where only one major launch ramp (Lime Saddle BR) exists. However, those areas are relatively narrow and with less surface areas than other zones, so lower use levels are generally appropriate.

Results of a joint pilot project being conducted by DPR and BOR at the Project Area reservoirs (and at other California reservoirs) will provide information classifying each zone of Lake Oroville and the other project reservoirs (pers. comm., Plunkett 2003). The classifications will be based on the existing recreation setting within a range of setting types using the water recreation opportunity spectrum (WROS) concept. The objective of WROS is to recognize and preserve a range of recreation opportunity choices for visitors. Lake managers may want to consider applying this information in future recreation planning to define the conditions to be managed for on each reservoir or reservoir zone. A clear statement of desired future conditions is a prerequisite for defining recreation carrying capacity for the reservoirs. The WROS information for Lake Oroville and the other Project reservoirs can assist in meeting the need for such a statement, which would contain three elements: (1) goals defining the recreation experience or experiences that are to be sustained over time in each area, (2) goals describing the resource conditions that are to be sustained over time in each area, and (3) definitions of the appropriate amount and type of use for each area. A draft report on the WROS pilot project is expected to be completed in fall 2004.

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APPENDIX A

Boater-Only Section of Recreation On-Site Survey

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River and Reservoir Boaters Only. If you have boated or expect to boat on this trip, please complete Q-29 through Q-40. Otherwise, skip to the next section.

Q-29. On this trip, at what site did you **primarily** boat? (**Circle one area; refer to map for sites or section**)

Lake Oroville
1. Main Basin
2. Lower North Fork
3. West Branch
4. Upper North Fork
5. Middle Fork
6. South Fork

Downstream Areas
7. Thermalito Diversion Pool
8. Thermalito Forebay
9. Thermalito Afterbay
11. Oroville Wildlife Area (Includes Feather River downstream of Highway 162)
12. Feather River (Diversion Pool to Highway 162)

Q-30. On this trip, did you personally experience any encounters with other users on the water that put you at risk?

1. Yes ➠ If Yes, where _____ (**Refer to map**)

Briefly describe the encounter _____

_____

2. No

Q-31. Did you observe any boating activity today that you felt put others at risk?

1. Yes ➠ If Yes, briefly describe unsafe activity_____

_____

2. No

Q-32. Please indicate how crowded you felt on the water today. (**Circle a number**) Skip to **Q-34** if you have not been on the water today.

1----------2----------3----------4----------5----------6----------7----------8----------9

Not at all	***Slightly***	***Moderately***	***Extremely***
Crowded	Crowded	Crowded	Crowded

Q-33. What type of watercraft do you **primarily** use when visiting the Lake Oroville Area? (**Circle one**)

1. Runabout/Pontoon/Cabin cruiser/Ski boat/Motorboat
2. Houseboat
3. Sailboat
4. Canoe/Kayak
5. Personal Watercraft (jet ski/ wave runner/etc.)
6. Other (Describe:_____)

Q-34. Do you own or rent the watercraft mentioned in **Q-33**, that you **primarily** use?

1. Own 2. Rent 3. Other (explain:_____)

Q-35. For the watercraft you primarily use, do you dock or moor it at Lake Oroville?

1. Yes ➠ Year round or Seasonal (**circle one**) 2. No

Q-36. Have you ever used one of the boat launches in the Lake Oroville Area?

1. Yes 2. No ➠ **(Skip to Q-41)**

Q-37. Which of the following boat launches have you used during the last 12 months? (**Circle all that apply**)

1. Lime Saddle
2. Spillway launch
3. Bidwell Canyon
4. Loafer Creek
5. Enterprise
6. N. Thermalito Forebay
7. S. Thermalito Forebay
8. Thermalito Afterbay Monument Hill
9. Thermalito Afterbay Larkin Road
10. Dark Canyon Car-Top
11. Stringtown Car-Top
12. Nelson Bar Car-Top
13. Vinton Gulch Car-Top
14. Foreman Creek Car-Top
15. Div. Pool-Burma Rd/RR Grade
16. River launch
17. Other _____
18. Other _____

Q-38. Which boat launch do you use most frequently? _____ (**Write in number from above**)

Q-39. Do you typically have to wait to use the boat launch you most frequently use?

1. Yes ➠ If Yes, on average, how many minutes do you have to wait to use this ramp?

   Number of minutes _____

2. No

Q-40. Overall, are you satisfied with your boating experience on this trip to the Lake Oroville Area?

1. Yes 2. No ➠ Why not?

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