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July 15, 2008
File No. 01030A

RE: Middle Fork American River Project Relicensing / Final 2007 Technical Study Report
AQ 2 – Fish Population

Dear Aquatic Resources Technical Working Group Member –

On March 11, 2008, Draft AQ 2 – Fish Population Technical Study Report (TSR) – 2007 was distributed to the Aquatic Resources Technical Working Group for review and comment by May 10, 2008.

As no comments were received on the draft TSR, PCWA deems AQ 2 – Fish Population Technical Study Report – 2007 approved.

Attached for your use is the CD containing the final study report.

If you have any questions, please don't hesitate to call me at (530) 823-4889.

Sincerely,
PLACER COUNTY WATER AGENCY

Mal Toy

Mal Toy
Director of Resource Development

MT:bb

Enclosure
Final AQ 2 – Fish Population Technical Study Report – 2007

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Placer County Water Agency
Middle Fork American River Project
(FERC No. 2079)

FINAL

AQ 2 - FISH POPULATION
TECHNICAL STUDY REPORT - 2007

Placer County Water Agency
P.O. Box 6570
Auburn, CA 95604

July 2008

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1.0 INTRODUCTION

This report describes the fish population study conducted by the Placer County Water Agency (PCWA) associated with the AQ 2 - Fish Population Technical Study Plan (AQ 2 - TSP), which was included in the Supporting Document (SD) H of the Pre-Application Document (PAD) for the Middle Fork American River Project (MFP or Project) (PCWA 2007). The study was conducted from the spring through fall of 2007 with the objective of documenting species composition, distribution, abundance, growth, condition factor, and age structure of fish in bypass[1] and peaking[2] reaches associated with the MFP, as well as comparison reaches. In addition, the study characterizes fish species, composition, relative abundance, and size of fish in Project reservoirs and diversion pools. Depending on site conditions, electrofishing, snorkeling, netting, or a combination of these methods were used to sample for fish.

A draft report was distributed to the Aquatics Technical Working Group (TWG) on March 11, 2008 for a 60 day comment period. The comment period ended on May 10, 2008. Oral comments were received at the March 10, 2008 Aquatics TWG meeting and have been addressed in this report. No written comments were received.

The following provides a detailed description of field data collection, data analysis and results.

2.0 STUDY OBJECTIVES

The objectives of the fish population study described in the AQ 2 - TSP (PCWA 2007) are:

- Document fish species composition, distribution, and abundance in the Project bypass and peaking reaches.
- Characterize fish growth, condition factor, and population age structure in the Project bypass and peaking reaches.
- Characterize fish species composition, relative abundance, and size in Project reservoirs and diversion pools.

[1]A bypass reach is a segment of a river or stream downstream of a diversion facility or reservoir where Project operations result in the diversion of a portion of the water from that reach. Bypass reaches associated with the MFP include: the Middle Fork American River between French Meadows Dam and Ralston Afterbay; the Rubicon River between Hell Hole Dam and Ralston Afterbay; Duncan Creek between the diversion dam and its confluence with the Middle Fork American River; and the North and South Forks of Long Canyon Creek and the mainstem of Long Canyon Creek from the diversion dams to the confluence with the Rubicon River.

[2]The MFP has a single peaking reach, which extends from Oxbow Powerhouse / Ralston Afterbay to the high-water mark of Folsom Reservoir. In this reach, flows fluctuate substantially to meet power demands or to support whitewater recreation.

Figure AQ 2-1 shows the AQ 2 - TSP study objectives and the study elements associated with each objective. It also shows where information developed is documented.

3.0 STUDY IMPLEMENTATION

Study elements described in the AQ 2 - TSP (PCWA 2007) were initiated in 2007 and will be completed in 2010. Study elements that have been completed and outstanding study elements along with any deviations from the AQ 2 - TSP study are discussed further below.

3.1. STUDY ELEMENTS COMPLETED

The following fish population study elements were completed in the spring through fall of 2007:

- Select 21 river fish population study sites according to the criteria in the AQ 2 - TSP in consultation with the Aquatic TWG including 10 sites in bypass reaches, three sites in the peaking reach, and eight sites in comparison reaches;

- Sample the 21 river fish populations study sites during the late summer/early fall base flow period, using a combination of electrofishing and snorkeling;

- Assess snorkeling efficiency and species identification by comparing snorkeling and electrofishing data collected at three sampling locations;

- Identify the upstream distribution of fish species in bypass reaches associated with the MFP;

- Sample fish populations in French Meadows and Hell Hole reservoirs, Middle Fork Interbay, and Ralston Afterbay in September using variable mesh gill nets;

- Sample fish populations in the North Fork Long Canyon Creek and South Fork Long Canyon Creek Diversion pools in September;

- Qualitatively sample, using electrofishing and/or seining gear, Duncan, North Fork Long Canyon, and South Fork Long Canyon creeks in spring/early summer to identify the timing and relative abundance of fry in the vicinity of Project diversions; and

- Qualitatively sample, using electrofishing and/or seining gear, upstream of Ralston Afterbay (Rubicon River and Middle Fork American River) to identify the approximate timing of hardhead spawning and early fry rearing in these reaches (spring/early summer).

3.2. DEVIATIONS FROM TECHNICAL STUDY PLAN

There were no deviations from the AQ 2 - TSP.

3.3. OUTSTANDING STUDY ELEMENTS

The following study elements will be completed in 2008 and 2009 and presented in the Technical Study Reports (TSR) listed below.

- Conduct fish population sampling in Duncan Creek Diversion Pool in September 2008 and Ralston Afterbay during spring and summer 2008. This information will be reported in the 2008 AQ 2 - TSR.

- Review the 2007 river fish population sampling data with the Aquatic TWG to determine which sites will be sampled in year two (2008) and possibly in year three (2009) to identify the temporal abundance of fish species. This information will be reported in the 2008 AQ 2 - TSR and 2009 AQ 2 - TSR.

- Identify appropriate fish standing crop comparison datasets in collaboration with the Aquatic TWG and with approval of the U.S. Department of Agriculture - Forest Service, (USDA-FS), California Department of Fish and Game (CDFG), and the State Water Resources Control Board (SWRCB). This information will be reported in the 2008 AQ 2 - TSR.

3.4. PROPOSED MODIFICATION TO TECHNICAL STUDY PLAN

No modifications are proposed to the AQ 2 - TSP.

4.0 EXTENT OF STUDY AREA

The study area includes bypass and peaking reaches, comparison reaches (i.e., reaches upstream of Project facilities and diversions and river reaches not affected by the Project), and Project reservoirs and diversion pools. Some portions of the study area are very difficult to access due to the rugged terrain (see Map AQ 2-1). Field data were collected only in portions of the study area that were accessible. Specific study areas are identified in Tables AQ 2-1 and AQ 2-2, and Map AQ 2-1.

5.0 STUDY APPROACH

The study approach for study site selection, river sampling, reservoir sampling, diversion pool sampling, special purpose qualitative sampling, and data analysis is provided below.

5.1. STUDY SITES

The quantitative study site locations for developing fish standing crop estimates (e.g., fish per mile and/or lbs per acre) in selected bypass, peaking, and comparison river reaches and for developing relative catch-per-unit-effort (CPUE) fish abundance in Project reservoirs and diversion pools are shown in Tables AQ 2-1 and AQ 2-2, and Map AQ 2-1. Appendix A includes representative pictures and descriptions of the quantitative river sampling sites.

River sampling sites (electrofishing and snorkeling) were at least 328 feet long (100 meters). The larger river sampling sites in the lower Rubicon and Middle Fork American rivers were typically much longer to include multiple habitat types. The specific

locations of the quantitative sampling sites were determined in the field in coordination with the Aquatic TWG in August 2007. The mesohabitat mapping results from the 2006 Aquatic Habitat Characterization Study (SD G, Book 2 of 2, Study Reports) (PCWA 2007) were used to help identify representative reach sampling sites with mesohabitat types in similar proportion to the larger geomorphic reaches of the river. Where possible, sampling sites were chosen that overlapped with the instream flow study sites (see the AQ 1 - Instream Flow TSP, which was included in SD H of the PAD (PCWA 2007) and CDFG historic sampling sites.

Sampling sites were chosen far enough upstream or downstream of access locations to minimize the effects of fishing on fish population results. One possible exception was a historic CDFG site that was sampled just upstream of Ellicott Bridge (see R20.9, Map AQ 2-1). Location consistency with historic sampling was an overriding factor in selection of this site. Table AQ 2-1 shows the specific location, length, sampling date, and sampling method for each sampling site.

Where river fish population comparisons were likely to be made between locations (e.g., upstream and downstream of Project diversion structures), comparison study sites were, as much as possible, located in sections of river with similar physical habitat and similar sampling methods were used. A summary assessment of the validity of comparing fish population density or biomass at each of the potential comparison sites based on comparability of physical characteristics with the sites is provided in Table AQ 2-3. Site comparison validity was qualitatively ranked as good, moderate, or poor for fish density/biomass estimates per length of stream and per area of stream. Appendix A contains detailed physical characteristic information for each potential comparison site. Physical habitat can affect the quality of habitat at a site and the number of fish within a site. Sites with similar types and abundance of linear habitat features (mesohabitat type, slope, channel type) are valid for comparison of density and/or biomass per length of stream. Sites with the above characteristics and with similar wetted width are valid for density and/or biomass per area comparisons. For example, sample sites with large differences in the wetted stream width that are otherwise similar (mesohabitat type, slope, channel type) comparison validity was ranked as good for fish density per mile, but poor for fish density per acre (area). For comparison sites with substantially different slope, comparison validity was ranked as poor for both fish density per mile and fish density per acre.

The reservoirs were sampled at three locations along the length of the reservoir using variable mesh gill nets (see maps in Appendix B). The small diversion pools were sampled in their entirety using snorkeling.

5.2. RIVER SAMPLING

The river study sites were sampled in 2007 to identify the spatial distribution and abundance of fish species. After the 2007 results are reviewed by the Aquatic TWG (this report), the Aquatic TWG will determine which sites will be sampled in 2008 and possibly in 2009 to identify the temporal abundance of fish species. The goal will be to sample a maximum of one to two sites per reach (Table AQ 2-1).

Quantitative river sampling was conducted from August 28 through October 11, 2007, during the late summer/early fall base flow period, using a combination of electrofishing (shallow water) and snorkeling (deep water) (Table AQ 2-1 and Map AQ 2-1). Multi-pass electrofishing (e.g., Reynolds 1996; Van Deventer and Platts 1989; Rexstad and Burnham 1992) was used to sample and estimate fish populations in shallow stream habitats (<1.5 m) at each representative reach study site. The representative reach sampling sites were partitioned into mesohabitat types using block nets. Captured fish from each pass were kept in separate live wells or buckets. Fish were anesthetized (CO_2), enumerated, identified to species, measured (fork length), and a subset sample of weights and scales from various sizes of fish was obtained. Fish were returned to the study site when the sampling was completed. Sampling protocols and field data forms were consistent with those in Flosi et al. 1998. Habitat data consistent with those taken during the 2006 Aquatic Habitat Characterization Study (PCWA 2007) were collected at the study sites. In particular, the lengths and widths of the habitat units sampled were recorded to calculate fish abundance by length and area of stream sampled.

In most cases, multi-pass electrofishing consisted of two very thorough electrofishing passes with equal sampling effort. Each individual pass consisted of an upstream shocking sweep and then a back downstream shocking sweep that was used to collect missed fish (missed during the upstream sweep), particularly fish that had collected near or on the downstream blocking net. If depletions did not exceed approximately 65% between pass one and pass two, a third pass was completed.

Snorkeling (e.g., Dolloff et al. 1996) was used to assess fish populations in deep water habitats (≥1.5 m) at study sites. Snorkelers surveyed in lanes along the river and identified, counted, and estimated the length of each fish observed into four size classes (0-3 in. , 3-6 in., 6-12 in., >12 in.) based on the current CDFG Wild Trout sampling protocols (R. Bloom, Pers. Comm. 2007). Fish data were recorded by habitat unit type and habitat information consistent with that collected during the 2006 Aquatic Habitat Characterization Study (PCWA 2007) was recorded. Snorkeling protocols and field data forms were consistent with those in Flosi et al. 1998. Juvenile minnows (i.e., hardhead, Sacramento pikeminnow, and/or California roach) were recorded as a single category, mixed minnow guild, where identification was uncertain (e.g., <6 inches in size). Very small fish of all species that could not be identified were recorded as fry.

Snorkeling efficiency and species identification were tested by comparing snorkeling and electrofishing data collected at three mesohabitat units where each technique was feasible. Sampling sites MF26.2, R3.5, and NF53.7 (see Map AQ 2-1) were chosen for comparisons due to the high likelihood that pikeminnow and hardhead were present. At all three sites, one deep run mesohabitat unit was chosen as the comparison habitat type. These three units were the first sites sampled.

Along the study reaches, qualitative presence/absence surveys (visual assessment, snorkeling, and electrofishing) were used to identify the upstream distribution of trout in North Fork Long Canyon Creek, South Fork Long Canyon Creek, and Duncan Creek. Qualitative snorkeling surveys were used to determine the late summer/early fall

distribution of hardhead between quantitative study sites on the Middle Fork American River and Rubicon River.

5.3. RESERVOIR SAMPLING

French Meadows and Hell Hole reservoirs, Middle Fork Interbay, and Ralston Afterbay were sampled from September 10 through September 21, 2007 using variable mesh gill nets. At least two nets were placed vertically at three sampling locations in each reservoir. Other nets were placed at an angle along the down sloping contour of the reservoir bottom. The three sampling locations were distributed along the length of the reservoirs (upper, middle, lower). Nets were set for approximately one day and one night. Captured fish were enumerated, weighed, and measured (fork length). The primary purpose of the sampling was to identify fish species composition, relative abundance (CPUE), and size.

5.4. DIVERSION POOL SAMPLING

The South Fork Long Canyon Diversion Pool was snorkeled in September and October 2007. The number, species, and size of fish in the diversion pool were identified. The North Fork Long Canyon Creek Diversion Pool was flowing through the low level outlet of the diversion. There was no diversion pool. The diversion was not in operation during the summer/fall sampling period and no fish were present in the portion of the stream typically within the footprint of the diversion pool (AQ Table 2-2).

5.5. SPECIAL PURPOSE QUALITATIVE SAMPLING

Qualitative sampling using electrofishing, hook-and-line, and/or seining gear was also used for the following purposes:

- To collect seasonal information on emergence and relative abundance of trout fry (i.e., to identify timing of spawning and early fry rearing) above the diversions on Duncan, North Fork Long Canyon, and South Fork Long Canyon creeks. Three sampling periods were equally spaced in time between early May and late June 2007 in the creeks. Similar sampling was also conducted upstream of Ralston Afterbay in the Rubicon River (four sampling periods) and the Middle Fork American River (three sampling periods) to identify the approximate timing of hardhead spawning and early fry rearing in these reaches. The sampling in these river reaches was approximately equally spaced between early May and late July 2007.

- To collect, where possible, additional trout and hardhead (few hardhead were captured) for scale analysis in various study sites in the Rubicon River and peaking reach to assist in develop of age versus growth relationships. The sampling was concentrated at study sites where snorkeling was the primary quantitative sampling methodology.

5.6. DATA ANALYSIS AND REPORTING

5.6.1. Fish Distribution Map

The results from the quantitative and qualitative fish population sampling were used to characterize the distribution of each fish species in the bypass and peaking reaches. A distribution map for rainbow trout, brown trout, hardhead, Sacramento pikeminnow, and California roach was created. Species were mapped as present in a reach where it was obvious from sampling that the species was distributed throughout a reach. Species distributions were mapped as uncertain where fish may be present, but no fish were observed or there was no sampling.

5.6.2. Fish Standing Crop

Fish standing crop estimates were generated for each species at each study site as density (fish per mile and fish per acre) and biomass (lbs per mile and lbs per acre). For each study site, the estimated number of fish (or biomass) was divided by the length (or area) of the study site to calculate fish standing crop estimates. Population estimates were calculated for each mesohabitat unit sampled within each site and then summed to obtain a total for the site. Multi-pass electrofishing population estimates for shallow mesohabitat units were calculated using the Van Deventer (1989) maximum likelihood method. For deep water mesohabitat units that were snorkeled, the number of fish observed during snorkeling was used as the population estimate.

5.6.3. Reach-Specific Standing Crop

Reach-specific density estimates were calculated by weighting the results from the sampling site by the reach-wide mesohabitat percentages. Mesohabitat percentages were derived from the results of the 2006 Aquatic Physical Habitat Characterization Study (PCWA 2007). The mesohabitat population estimates at a site were weighted by the percentage of the corresponding mesohabitat type in the reach. If a mesohabitat type was not sampled in a study site, but present in a reach, the reach-specific density estimate was calculated for only the mesohabitat types present in the study site. Also, if a study site was in a comparison river reach where the percentage of mesohabitat types was not mapped, the mesohabitat percentages in the river site where the comparison was being made were used.

5.6.4. Trout Biomass

The biomass of rainbow and brown trout per acre was calculated at each site. The biomass of other species was not calculated because typically too few fish were captured to develop meaningful biomass estimates. Also little historical biomass information exists for other species. Trout biomass, either rainbow or brown trout, was calculated as the average fish weight at a site multiplied by the estimated number of fish at the site. When some fish were not weighed (only measured) at a site, their weight was calculated using a length-weight regression developed for the site. If an accurate site specific length-weight regression was not available, then a general study-wide data set length-weight regression was used. For snorkeling sites, the midpoint length of each fish size class bin was used to calculate average biomass using either a site specific or the study-wide length-weight regression. Snorkeling biomass estimates were

used as relative measures of biomass between snorkeling sites and between snorkeling and electrofishing sites. The estimates are likely not as accurate as those at electrofishing only sites.

5.6.5. Age Structure

Age structure was determined using a combination of length-frequency histograms and scale analysis for each fish species at each site. The size range of the young-of-the-year (YOY) cohort was easily estimated based on the length-weight histograms. The age of older fish was determined with scale analysis. Fish were aged by counting the annuli on magnified scales. The reading of scales was done by an experienced fish biologist.

5.6.6. Growth Rates and Condition Factor

Growth rates were calculated by plotting length versus age for fish that were aged using scale analysis. Fulton's condition factor (Ricker 1975) was calculated for each trout. Individual condition factors (K) were calculated by

$$K = \text{weight (g)} \times 100{,}000 / (\text{fork length (mm)})^3$$

The average condition factor for adult trout was calculated from individual condition factors for adult trout at each site.

5.6.7. Fish Periodicity Chart

A fish life stage periodicity chart (or life history chronology chart by month) for each species in the study reaches was developed based on available literature (Moyle 2002), consultation with qualified fisheries biologists, and a review of the results of the fish population sampling.

5.6.8. Water Temperature

Water temperature data from sensors deployed during 2007 were used to create a watershed-wide temperature map (Map AQ 2-2) and table (Appendix A - Table AQ A-2). The actual locations of the sensors are provided in the 2006 Water Temperature Study Report, which was included in SD G Book 2 of 2 Study Reports of the PAD (PCWA 2007). Water temperature ranges for the map was linearly interpolated between sensors.

5.6.9. Electronic Database

An electronic database (Excel spreadsheet) of all the fish sampling data (date, location, fish species, fish size, sampling pass, etc) was developed and provided to the Aquatic TWG on the CD accompanying this report.

6.0 RESULTS

6.1. DISTRIBUTION AND DIVERSITY

6.1.1. Rivers

Distribution - The pattern of species distribution in the study area was primarily indicative of water temperature. Coldwater trout were the most widely distributed of the 15 species of fish observed at the study sites (Table AQ 2-4, Map AQ 2-1, Appendix C, and Appendix D). Rainbow trout were present in all sampling locations and brown trout were present in all sampling locations except those in the Long Canyon creeks and the two comparison rivers (North Fork American River above Lake Clementine and North Fork of the Middle Fork American River).

Warmer water minnow species (hardhead, Sacramento pikeminnow, and California roach) were relatively rare and patchily distributed. Hardhead in particular were only observed in a few locations. These locations were Ralston Afterbay and the rivers immediately upstream of Ralston Afterbay and in a pool in Otter Creek at its confluence with the Middle Fork American River. Young mixed minnows (<6 in.) were observed during snorkeling at several other locations, but they were too small to differentiate between hardhead and/or pikeminnow (Table AQ 2-4). The approximate distribution of trout and minnow species in the bypass and peaking reaches is shown in Figure AQ 2-2. There is uncertainty in the distribution of minnow species, however, due to the patchiness of the observations.

Supplemental qualitative snorkeling during the fall was used in an attempt to better define the minnow distribution (particularly hardhead) in the rivers upstream of Ralston Afterbay. Hardhead were not observed in the additional sampling and minnows in general were difficult find. There appeared to be more minnows in pools during the summer (casual observations during other field work) than during the fall sampling. Some type of movement or hiding behavior may have occurred with cooling temperatures. Table AQ 2-4 shows the additional qualitative sampling locations.

Sacramento sucker and sculpin were the most widely distributed species other than trout. They were found together in the same sampling locations. These were the sampling sites in the peaking reach, the comparison rivers, the lower portion of the Rubicon River and the Middle Fork American River immediately upstream of Ralston Afterbay. Centrachids, smallmouth bass and green sunfish, were only captured at one location, the warm water North Fork American River above Lake Clementine. White catfish were also captured at this location.

Diversity - The highest river fish diversity (6-8 species) was found in the warmer sections of river. These were the Middle Fork American River and Rubicon River sampling sites just upstream of Ralston Afterbay and in the comparison river sampling sites (North Fork American River upstream of Lake Clementine, North Fork of the Middle Fork American River) (Table AQ 2-4). The lowest diversity was found in the higher elevations (colder water) streams. Trout were the only species present in the

Middle Fork American River above Middle Fork Interbay and in Duncan Creek (rainbow trout and brown trout) and in Long Canyon creeks (rainbow trout only).

Above Small Stream Diversions - The upstream distribution limit of fish above the small stream diversions (Duncan, North Fork Long Canyon, and South Fork Long Canyon creeks) was determined based on qualitative surveys (Figure AQ 2-2, Appendix C). The primary factor limiting the upstream fish distributions was insufficient flow to maintain a connected channel. Brown trout and rainbow trout were present 5.0 miles upstream of the Duncan Creek Diversion, including the lower 1.3 miles of Little Duncan Creek. Rainbow trout were found 1.8 miles and 6.2 miles upstream of the North Fork Long Canyon Creek Diversion and the South Fork Long Canyon Creek Diversion, respectively.

Historic River Distribution - Little information is available on the historic fish distribution in the study rivers. Fish and Aquatic Resources, Section 6.0 in SD F of the PAD (PCWA 2007) presented historical fish distribution information. Much of the information obtained regarding species distributions was derived from statements in secondary sources (e.g., TNF 2003) and little primary source data was found (e.g., sampling records). Details regarding historic river distributions, where available and applicable, will be presented in the 2008 sampling report as part of the standing crop comparison datasets.

6.1.2. Reservoirs

All of the reservoirs contained rainbow and brown trout (Table AQ 2-5). Hell Hole Reservoir had the greatest species diversity with four additional species (six total), including lake trout, kokanee salmon, Tui chub, and Sacramento sucker. French Meadows Reservoir had two additional species (four total), kokanee salmon (only one individual captured) and Tui chub. Ralston Afterbay contained hardhead, Sacramento pikeminnow, and Sacramento sucker in addition to rainbow and brown trout. Only rainbow and brown trout were present in Middle Fork Interbay.

Historical data from the Project reservoirs is provided in Table AQ 2-5. Lake trout and kokanee salmon are not recorded in the historical sampling data. Both species, however, are known to exist in Hell Hole Reservoir. Lake trout were stocked and currently are self sustaining. Kokanee salmon are stocked annually. In the 2007 sampling, kokanee salmon were present in both Hell Hole and French Meadows reservoirs, and lake trout were present in Hell Hole Reservoir. Other historical experimental stockings in Hell Hole Reservoir including rainbow/cutthroat trout crosses and coho salmon were not observed in 2007.

6.2. ABUNDANCE

For each river quantitative sampling site, fish population estimates by species for electrofishing and snorkeling are shown in Appendix D - Table D-2. Fish density (fish per mile and fish per acre) is shown in Tables AQ 2-6 and AQ 2-7, respectively, and in Figure AQ 2-3. Reach-specific versus site-specific density estimates are shown in Figure AQ 2-4. The reservoir CPUE is shown in Table AQ 2-5 and Figure AQ 2-5.

6.2.1. Trout

Rivers and Streams - Trout density was greatly affected by the number of YOY present. Generally the small streams had the highest density, intermediate-sized streams/rivers had intermediate density, and the largest rivers had the lowest density. The highest linear trout densities (3,500 to 6,500 per mile) were found in the Long Canyon Creek drainage (Long Canyon Creek, South Fork Long Canyon Creek, and North Fork Long Canyon Creek) and at one site on the Middle Fork American River above French Meadows Reservoir. Intermediate densities (1,000 to 3,500 trout per mile) were observed in Duncan Creek, all but one site on the Rubicon River, and the Middle Fork American River between Middle Fork Interbay and French Meadows Reservoir. The lowest densities (<1,000 trout per mile) were found in the comparison river sites, the Middle Fork American River and Rubicon River sites immediately upstream of Ralston Afterbay, and the peaking reach sites.

Trout density per acre generally exhibited a similar pattern as density per mile, except that density per acre in sites with wide channels decreased relative to sites with narrower channels. Some notable locations where fish density per area decreased relative to other sites due to wider channels were the lower Duncan Creek site (D6.3) and the Middle Fork American River site above French Meadows Reservoir (MF51.8). One location where density per area increased relative to other nearby sites because the channel was narrower was the Rubicon River site above Hell Hole Reservoir (R36.2).

The pattern of highest YOY trout densities (per mile and per acre) was generally similar to the total trout densities. The highest densities were in Long Canyon Creek, North Fork Long Canyon Creek, and South Fork Long Canyon Creek. The Middle Fork American River in the low gradient section just upstream of French Meadows Reservoir had similarly high densities of YOY per mile. However, YOY densities per acre were lower at this location because of the wide channel (large area per length of stream). Intermediate YOY trout densities (per mile and per acre) were found in Duncan Creek, the Middle Fork American River upstream of Middle Fork Interbay, and in the Rubicon River from Ellicott Bridge upstream. Low densities of YOY trout were found in the comparison river sites (North Fork American River, North Fork of the Middle Fork American River), in the sampling sites just upstream of Ralston Afterbay (Rubicon River and Middle Fork American River), and in the peaking reach.

Reach-Specific Standing Crop - Generally, there was little difference in the results between the site-specific density estimates and the reach-specific estimates (i.e., fish density scaled by the percent of mesohabitat types in the reach) (Figure AQ 2-4). The mesohabitat types at each fish population sampling site were sampled approximately in proportion to the percentage of mesohabitats in the reach; therefore, the results between the site-specific and the reach-specific density estimates were similar. There were, however, two exceptions. The density estimates for the sampling sites on the Rubicon River near Ellicott Bridge (R20.9) and on Duncan Creek below the diversion (D6.3) increased when the reach mesohabitat weightings were used. At both of these sites, proportionately more pool habitat, particularly in terms of area, was sampled than was present in the reach. At the site near Ellicott Bridge this occurred because the site

was a historic CDFG electrofishing site with preexisting boundaries and the pools that were snorkeled (added to the site for this study) were very large (long and wide). At Duncan Creek the percentage of pool habitat by length was approximately correct, but the pools were very wide and, based on area, made up a large percent of the habitat compared to the other habitat types sampled. The sampling site and reach mesohabitat types and percentages are provided in Appendix A - Table A-1.

The most important implication of these results is that the percent of mesohabitat types sampled either in terms of length or area can affect the density estimates. The sampling effort in this study (i.e., mesohabitat sampled approximately in proportion to the percentage in the reach), generally controlled for this effect. There were exceptions particularly with respect to area sampled. Because of this, the Duncan Creek site (D6.3) in particular, which is being used as a below and above diversion comparison site, should likely be compared only on a linear density basis (fish per mile) with its reference site.

Reservoirs - Brown trout and rainbow trout were abundant in each of the reservoirs. Sacramento sucker were the most abundant species in Hell Hole Reservoir and Ralston Afterbay and kokanee salmon were common in Hell Hole Reservoir. Other species, when observed (hardhead, Sacramento pikeminnow, Tui Chub, lake trout), were typically captured in low abundance. Historical gill net sampling (1966 - 1985) generally indicates higher catches of fish of all species (Table AQ 2-5). For trout and kokanee salmon this may be related to stocking, however, the available data for stocking is discontinuous and a clear relationship is difficult to discern. The available stocking data for the reservoirs is provided in Fish and Aquatic Resources, Section 6.0 in SD F of the PAD (PCWA 2007).

6.2.2. Hardhead/Pikeminnow

Based on the fish population sampling results, hardhead were rare in the study area. A total of seven hardhead were captured in the fall quantitative sampling sites (Tables AQ 2-6, AQ 2-7, and Appendix D - Table AQ D-1), six in Ralston Afterbay and one in the Middle Fork American River above Ralston Afterbay. In contrast, over 4,000 rainbow trout were observed. A number of hardhead (78 total) were captured during qualitative sampling in the spring/early summer conducted in the Middle Fork American and Rubicon rivers just upstream of Ralston Afterbay. Most of these fish were small; the largest was 138 mm. Likely there were also some young hardhead included as part of the small mixed minnow fish guild that were counted during snorkeling in the comparison river sites and the peaking reach at MF4.8 (Appendix D Table AQ D-1). However, based on qualitative electrofishing and seining surveys, the majority of the fish comprising the mixed minnow guild appeared to be pikeminnow and California roach.

Sacramento pikeminnow were slightly more abundant than hardhead, but adult fish were relatively rare. A total of 52 pikeminnow were captured or large enough to positively identify during fall quantitative surveys. Five of these fish were captured in Ralston Afterbay and the remainder were captured in the river sites (MF 26.2, R3.5, NFMF2.3, NF31.3, NF53.7). Twenty-one pikeminnow greater than 152 mm (6 in.) in

length were observed. The fish were observed at two sites, Ralston Afterbay and the North Fork American River NF31.3 site (both quantitative and qualitative sampling). A total of 213 pikeminnow were captured during qualitative sampling conducted in the Middle Fork American and Rubicon rivers just upstream of Ralston Afterbay during the spring/early summer (Appendix D - Table D-1 and Appendix C - Table C-2). These were young fish (largest was 97 mm). In the North Fork American River comparison sites and in the peaking reach at MF4.8 there were also a number of mixed minnow observed that likely consisted largely of pikeminnow (Table AQ 2-4, Appendix D - Table D-1).

6.3. TROUT BIOMASS

Trout biomass varied depending on whether it was evaluated linearly (pounds per mile) or on an area basis (pounds per acre) (Figure AQ 2-3, Table AQ 2-8). Linear biomass was highest (>150 lbs/mile) at several of the large river bypass and peaking reach sites (e.g., MF14.1). On an area basis, biomass was highest at the Long Canyon creeks sites (>50 lbs/acre). The high biomass large river sites (MF14.1) were composed primarily of larger fish, while the high biomass small stream sites were composed primarily of abundant small fish.

The sites with the lowest biomass (e.g., <50 lbs/mile or <10 lbs/acre) were generally the same for both reporting methods (biomass per mile or per area). The comparison river site on the North Fork American River (NF31.3) had the lowest trout density. Summer water temperatures were high at this location (see Map AQ 2-2 and Appendix A - Table A-2). The other low biomass sites were the farthest downstream site in the peaking reach (NF18.4) and the Rubicon River (R3.5), and the highest elevation site on the Middle Fork American River above French Meadows Reservoir (MF51.8). The downstream Rubicon River site (R3.5) had relatively high summer temperatures and the upper Middle Fork American River site (MF51.8, above French Meadows Reservoir) was wide, shallow, and had low flow and relatively warm water temperatures, and was dominated by YOY. Water temperature did not appear to be high enough to explain the low biomass at NF18.4.

6.4. FISH POPULATION COMPARISON SITES

Overall, fish density and biomass was similar between the study sites in the bypass and peaking reaches and the comparison sites. The above and below diversion comparison sites were very similar based on linear fish density (fish/mile) or biomass (lbs/mile) estimates. However, at other comparison sites, fish standing crop varied depending on the metric used. For example, sometimes density was higher at the comparison sites, but biomass was lower, or vice versa. For one set of comparisons, there was a consistent difference. The site on the North Fork American River (NF31.3), that was chosen as a potential reference site to compare to the peaking reach sites (NF18.4, MF4.8, and MF14.1), had lower trout density and biomass than the peaking reach sites; however, temperature was different at the sites. The summer temperature at the North Fork American River site was high; therefore, trout density and biomass were smaller in the comparison site than in the peaking reach sites. The density of other species at this comparison river site was relatively low as well. Tables AQ 2-6, AQ 2-7, and AQ 2-8

show the comparisons of fish density and biomass between the study sites and the comparison sites. Figures AQ 2-6 and AQ 2-7 show the comparison density and biomass results side-by-side. Appendix D - Table D-2 shows the average weight of rainbow and brown trout at each site.

The validity of the study site comparisons based on physical habitat characteristics is shown in Table AQ 2-3 and the potential fish population comparison sites are discussed in detail below. They are categorized into: (1) upstream and downstream diversion sites; (2) upstream and downstream reservoir sites; and (3) comparison rivers versus bypass or peaking reach sites.

6.4.1. Upstream and Downstream Diversions Sites

South Fork Long Canyon Diversion - Trout density and biomass were similar upstream (SFLC4.2) and downstream (SFLC2.3) of the South Fork Long Canyon Diversion. The only metric that differed was trout density per acre. It was lower downstream of the diversion. There were similar numbers of fish per length of stream upstream and downstream of the diversion, but the channel was wider downstream and the number of fish per area, therefore, decreased. The average fish size was slightly larger at the downstream site (9 g versus 8 g). The linear biomass (lbs/mile) was slightly higher downstream. The two sampling sites were physically similar aside from a slightly wider channel and lower gradient downstream of the diversion (Table AQ 2-3 and Appendix A - Table A-3).

North Fork Long Canyon Diversion - Trout density and biomass were slightly lower upstream (NFLC 3.8) of the diversion than downstream (NFLC 1.9). The average fish weight was the same between the two sites (11 g). The stream slope was less downstream (3.5%) of the diversion than upstream (6.6%) of the diversion. Because of gradient, the sites were physically dissimilar (validity of comparison ranked as moderate) (Table AQ 2-3 and Appendix A - Table A-3). The diversion structure is located very near a natural break in channel slope.

Duncan Creek Diversion - Trout linear density and biomass was similar upstream (D9.0) and downstream (D6.3) of the diversion. However, area-based density and biomass (trout per acre and lbs per acre) were higher upstream of the diversion (D9.0) than downstream (D6.3). At the site downstream of the diversion, the wetted channel was approximately twice as wide as at the upstream site (Table AQ 2-3); therefore, standing crop estimates based on area were lower (about 50% lower). Average fish size was slightly lower downstream of the diversion (12 g versus 16 g). The two sites were similar physically except for the much wider channel at the site downstream of the diversion. The validity of the comparison based on physical characteristics of the sites was ranked as good for linear estimates and poor for area based estimates.

6.4.2. Upstream and Downstream Reservoir Sites

Physical channel habitat at the sampling sites upstream and downstream of French Meadows Reservoir and upstream and downstream of Hellhole Reservoir was dissimilar (validity of the standing crop comparisons was ranked as poor) and, therefore, the comparisons should be viewed cautiously (Table AQ 2-3).

French Meadows Reservoir - Trout (rainbow and brown trout) density per mile and per acre was greater upstream of French Meadows Reservoir (MF51.8) than downstream (MF44.7). This occurred because of the larger number of YOY (>90% of the population) in the low gradient site upstream of the reservoir. Biomass, however, was higher downstream of the reservoir than upstream because the average fish size was larger downstream (<45% YOY). The channel type, slope, and pool depth (and water temperature) were dissimilar above and below the reservoir (Table AQ 2-3).

Hell Hole Reservoir - Trout density per mile and biomass (lbs per mile and lbs per acre) was lower upstream (R36.3) of Hell Hole Reservoir than downstream (R25.7); however, density per acre was greater upstream. The wetted width of the Rubicon River upstream of Hell Hole Reservoir was smaller than downstream of the reservoir; the area sampled upstream of the reservoir was half of that sampled downstream of the reservoir per length of stream. In spite of this relationship, biomass (lbs per acre) was larger downstream of the reservoir. This occurred because the average fish weight was greater downstream (Appendix D - Table D-2). Above the reservoir, the majority of the population was YOY; below the reservoir, more adults were present, particularly in the deep pools sampled by snorkeling. Channel type, slope, wetted width, and pool depth were dissimilar above and below the reservoir (Table AQ 2-3).

6.4.3. Comparison River Sites Versus Peaking or Bypass Reach Sites

Bypass Reaches - The North Fork of the Middle Fork American River (NFMF2.3) comparison site was similar physically to the Middle Fork American River bypass reach site just upstream of Ralston Afterbay (MF26.2) (Table AQ 2-3). In terms of adult trout the two sites had nearly identical densities (per mile and acre); however, the NFMF2.3 site had more YOY fish. Biomass was higher in the bypass site (MF26.2) because the average size of the fish at MF26.2 was higher. The diversity of species was very similar between the two sites.

The upper North Fork American River (NF53.7) comparison site was physically similar to the two lower Rubicon River bypass reach sites (R3.5 and R20.9) (Table AQ 2-3). The trout density and biomass at the comparison site (NF53.7) was intermediate between that at the two Rubicon River sites. The R3.5 site density and biomass was lower and the R20.9 site density and biomass was substantially higher than that at the NF53.7 comparison site. The percentage of YOY was higher in both of the Rubicon River sites than at the comparison site. Species diversity at the NF53.7 comparison river site was similar to that in the R3.5 bypass reach site, except that brown trout were not observed in the comparison site. Species diversity was lowest at R20.9 where only rainbow and brown trout were observed.

Peaking Reach - The best physical channel (and elevation) comparison sampling site for the peaking reach was the sampling site on the North Fork American River near Ponderosa Bridge (NF31.3). This site was physically comparable to the sites in the peaking reach (MF4.8, MF14.1, and NF18.4) (Table AQ 2-3). The North Fork American River comparison site, however, had very few fish. In terms of trout, only three rainbow trout were observed in 3,195 feet of river snorkeled. The peaking reach sites had many more trout (rainbow and brown trout). At the Ponderosa Bridge site (NF31.3) the water

temperature was high. The average August 2007 water temperature exceeded 74°F and the maximum water temperature was 82.7°F. In the peaking reach the average August 2007 water temperature was about 65°F.

All of the sites (North Fork American River comparison site and peaking reach sites) had Sacramento sucker and sculpin. In terms of warmer water species, the Ponderosa Bridge site had young mixed minnows, smallmouth bass, and green sunfish. These species were not observed in some of the peaking sites. The numbers of individuals of these species at the Ponderosa Bridge site, however, was low. The only substantial numbers of individuals observed was at an uncharacteristically large pool immediately below the Ponderosa Bridge crossing that was sampled as a qualitative sampling site. This pool was sampled in an attempt to understand why the fish numbers were relatively low in the downstream sampling site. The large pool contained several large adult pikeminnow (8), smallmouth bass (35), and Sacramento suckers (15).

6.5. FISH SIZE, AGE, GROWTH, AND CONDITION FACTOR

6.5.1. Trout and Kokanee Salmon

Trout throughout the study area were relatively small. In the small streams (Duncan Creek and the Long Canyon creeks) most fish were less than approximately 215 mm (Figure AQ 2-8). The largest trout were observed in the pools of the large rivers (snorkeling); however, even in the large rivers most fish were less than 305 mm (12 in.). The study sites with the largest number and percentage of trout greater than 305 mm were the peaking reach study sites (NF 18.4, MF4.8, and MF14.1). Several fish larger than 457 mm (18 in.) were observed at these sites, but the size class breaks used for snorkeling did not include a category for fish of this size. The length frequency histograms for each river sampling site are shown in Appendix E. The overall small size of trout in the study area should be accounted for when developing habitat suitability criteria for the instream flow modeling AQ 1 - TSP (PCWA 2007).

The smallest trout captured in the reservoirs using gill nets was 230 mm and the largest was 730 mm (Figures AQ 2-9a and AQ 2-9b). Most of the rainbow and brown trout captured in the reservoirs were less than about 500 mm. There were a few larger fish captured in the large reservoirs (Hell Hole and French Meadows reservoirs). The largest fish was a brown trout (730 mm) captured in French Meadows Reservoir. Kokanee salmon ranged from 294 - 418 mm in Hell Hole Reservoir and the one kokanee captured in French Meadows Reservoir was 430 mm.

An analysis of age and growth for rainbow trout (age measured from scales) showed variability in age structure and growth rate between sampling sites (Figure AQ 2-10). The number of scale samples collected at some sites was low (Appendix D - Table D-3) so caution is required when interpreting the results. However, rainbow trout captured in the peaking reach (MF14.1) and lower Rubicon River (R3.5) had the fastest growth rates and typically the largest fish at each age class. Rainbow trout in the small streams had the slowest growth rates. Sizes at age 0+ and 1+ were similar between the small streams and larger river sites, but by age 2+ and 3+ fish in the larger river

sites were larger. The oldest rainbow trout captured was an age 4+ fish (one fish) in the peaking reach (MF14.1) (Figure AQ 2-10). At most sampling sites, the oldest rainbow trout captured were age 3+. Older fish likely were present in the large river sites where snorkeling was used as the primary sampling method, but these fish were not captured for age analysis.

The condition factors of trout in the rivers and streams were on average 1.08 (Table AQ 2-9). Higher or lower condition factors indicate fish in better or poorer condition, respectively. In general, condition factors provide a method to compare the relative nutritional state or growth/plumpness of fish. There was no obvious difference between the condition factors of fish at the different river study sites. The average condition factor for reservoir fish was similar to that in rivers, however, due to morbidity of the fish in the gill nets and predation by crayfish on the fish captured in the gill nets, the results are less certain.

The length versus weight regression equations for rainbow and brown trout at each river sampling site are provided in Appendix D - Table D-4. The equations were used to calculate the weight of fish when only lengths were measured. In particular, the equations were used for biomass calculations to estimate the weight of snorkeled fish. For study sites without enough measured fish to generate a regression, a general study site regression was developed (i.e., all measured fish from the study were combined).

6.5.2. Hardhead and Sacramento Pikeminnow

Very few adult hardhead or Sacramento pikeminnow were observed or captured (see Section 6.2.2). Hardhead ranged in size from 35 - 471 mm. Sacramento pikeminnow ranged in size from 25 - 445 mm. The largest fish collected were from Ralston Afterbay. The five largest hardhead (347 - 471 mm) were aged using scale samples. They ranged from 4+ to 8+ years old. The three largest pikeminnow that could be aged (some scale samples collected had regenerated scales and could not be aged) were 3+ to 7+ years old (245 - 445 mm). Nine smaller pikeminnow and two hardhead collected in the fall between 57 - 149 mm were aged. The fish greater than approximately 100 mm were 1+ and those less than approximately 100 mm were 0+ years old.

6.6. TIMING OF FRY

Spring and early summer qualitative sampling data are shown in Figure AQ 2-11 and Appendix C - Table C-3 for each of the qualitative study sites.

6.6.1. Rainbow and Brown Trout Fry

Rainbow trout YOY were observed by the end of June at all of the qualitative sampling sites and it appears that spawning occurred in April and May in the higher elevation streams and perhaps as early as March in low elevation tributaries. The earliest rainbow trout YOY (and brown trout YOY) were found was the first sampling date, May 11th, in Gas Canyon Creek, a tributary to the peaking reach. Rainbow trout YOY were found in the Middle Fork American River and Rubicon River just upstream of Ralston Afterbay, and in North Fork Long Canyon Creek above the diversion in early June (June 5-7). Brown trout fry were found in the Middle Fork American River just upstream of Ralston Afterbay at the same time. Approximately 3 weeks later (June 26), rainbow

trout YOY were captured in Duncan Creek and South Fork Long Canyon above the diversions. Rainbow trout eggs hatch and emerge in 5-7 weeks (at 10-15˚C) (Moyle 2002). These dates suggest that rainbow trout spawning occurred in April and May in Duncan Creek, North Fork Long Canyon Creek, and South Fork Long Canyon Creeks. Rainbow trout in Gas Canyon Creek may have spawned in March.

6.6.2. Hardhead-Pikeminnow-Sucker Fry

It appears hardhead YOY were captured in the Rubicon River upstream of Ralston Afterbay in the May 11th sampling. It also appears that both hardhead and pikeminnow YOY were captured in the Middle Fork American and Rubicon rivers upstream of Ralston Afterbay in the early June (June 5-7) sampling. This is based on the assumption that hardhead and Sacramento pikeminnow less than about 50 mm (30-50 mm) were YOY during spring 2007. If this assumption is true, spawning occurred prior to May. Some uncertainty exists regarding the timing of spawning and appearance of YOY hardhead and Sacramento pikeminnow. Limited numbers of hardhead and pikeminnow were collected during the fall of 2007 and as a result the minimum size of YOY fish in the fall is uncertain and, therefore, the size of 1^+ fish in the spring is somewhat uncertain. It is possible that the 30-50 mm fish observed in the spring 2007 were 1^+ fish, but this does not seem likely.

Sacramento sucker were observed actively spawning in the Rubicon River immediately upstream of Ralston Afterbay on May 11th. However, Sacramento sucker YOY were first captured approximately 2 months later (July 16th) in a different sampling location, Middle Fork American River immediately upstream of Ralston Afterbay.

6.7. Electrofishing Versus Snorkeling Efficiency and Accuracy

The electrofishing versus snorkeling results for the three sites sampled were similar for count and identification of adult fish (Table AQ 2-10) at two of the sites. At one run habitat site with large substrate, the snorkel count was lower for adult trout than the electrofishing count. No large hardhead or Sacramento pikeminnow (e.g., >6 inches) were captured at the comparison sites. One of the primary goals of the snorkeling versus electrofishing comparison was to test the snorkeling identification of hardhead versus Sacramento pikeminnow for fish greater than 6 inches. Due to the scarcity of hardhead and pikeminnow, habitat could not be found with hardhead or pikeminnow (>6 inches) that could be electrofished (water depth <1.5 meters).

6.8. Small Stream Diversion Pool Sampling

Low numbers of fish (11 rainbow trout) were observed in the South Fork Long Canyon Creek Diversion Pool in September (Table AQ 2-11). The North Fork Long Canyon Diversion Pool was a very small stream running through the low level outlet during the summer/fall at the time of the surveys (no diversion pool was present). No fish were present in the stream. The Duncan Creek Diversion Pool was visited twice in the fall of 2007. An accurate count was not possible during the first visit due to poor visibility from a recent rain event. On the second visit, a total of three trout were observed; one brown trout, one rainbow trout, and one unidentified adult trout. However, water clarity was not

optimum due to periodic storm events that were occurring in October, therefore these estimates may not be accurate.

6.9. SPECIES AND LIFESTAGE PERIODICITY

A species and lifestage periodicity chart for the reaches associated with the MFP was developed using data collected as part of the sampling (e.g., qualitative spring fry emergence sampling), information contained in Moyle (2002), and general biological knowledge (Table AQ 2-12). The periodicity chart will be used in the instream flow modeling AQ 1 - TSP (PCWA 2007).

6.10. WATER TEMPERATURE

The spatial pattern of average August water temperature indicates that most of the bypass reaches and peaking reach provide habitat (e.g., water temperature <70^{o}F) for trout (Map AQ 2-2 and Appendix A - Table A-2). The only bypass reach locations where water temperature was 70^{o}F or greater were the lower Rubicon River and lower Long Canyon Creek.[3] Comparison streams with warm water temperatures were the North Fork of the Middle Fork American River and the North Fork American River in the vicinity of Lake Clementine.

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[3]The MFP does not affect flows and, thus, water temperatures in Long Canyon Creek during the summer and fall.

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Personal Communication

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TABLES

Table AQ 2-1. River Fish Population Study Site Locations and Sampling Reaches.

Study Sites[1]	Reach Type			Downstream Starting Location (UTM)[2]		Reach Name[3]	Rosgen Level I/II Channel Type[4]	Elevation (ft)	Site Length (ft)	Survey Date	Survey Method[5]	Study Reach Description
	Peaking Reach	Bypass Reach	Reach Upstream of Project Facilities or Comparison Rivers	Easting	Northing							
Middle Fork American River Downstream of Ralston Afterbay												
MF4.8	●			675208	4310856	MFAR-R1	F	643	3877	Oct 3, 2007	S	Middle Fork American River from confluence Canyon Creek to confluence with North Fork American River
MF14.1	●			685474	4313591	MFAR-R3	F	797	3374	Oct 2, 2007, Oct 16, 2007	S	Middle Fork American River from Ralston Afte confluence with Canyon Creek
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay												
MF26.2		●		696565	4320226	MFAR-R4	Bc/F	1188	971	Sep 18, 2007	S, E	Middle Fork American River from Middle Fork to Ralston Afterbay
Middle Fork American River Upstream of Middle Fork Interbay												
MF36.2		●		708258	4322377	MFAR-R5	Ba/Fb	2577	534	Sep 20, 2007	S, E	Middle Fork American River from confluence Duncan Creek to Middle Fork Interbay
MF44.7		●		716691	4330009	MFAR-R5	Ba/Fb	4505	710	Sep 26, 2007	S, E	Middle Fork American River from French Mea confluence with Duncan Creek
MF51.8			●	723863	4335353	Comparison Reach	B3	5295	660	Oct 11, 2007	E	Middle Fork American River upstream of Fren Meadows Reservoir
Rubicon River												
R3.5		●		699586	4317545	RUB-R1	Bc/F	1325	1427	Sep 17, 2007	S, E	Rubicon River from Long Canyon Creek Conf to Ralston Afterbay
R20.9		●		717835	4315183	RUB-R2	B/Fb	3350	1224	Sep 19, 2007	S, E	Rubicon River from Deer Creek to Long Car Creek Confluence
R25.7		●		720929	4320677	RUB-R3	C	3927	413	Sep 25, 2007	S, E	Rubicon River from Hell Hole Reservoir to De Creek
R36.2			●	731393	4328025	Comparison Reach	B3	4800	688	Sep 27, 2007	E	Rubicon River upstream of Hell Hole Reservo
Long Canyon Creek												
LC9.0		●		712179	4319355	LONG-R2	F	3740	543	Oct 8, 2007	E	Long Canyon Creek from North and South Fo Canyon creeks confluence to confluence with Rubicon River

[1]Site ID includes a river abbreviation and river mile location. MF= Middle Fork American River; R = Rubicon River; LC = Long Canyon Creek; SFLC = South Fork Long Canyon Creek; NFLC = North Fork Long Canyon Creek; D = Duncan Creek; NFMF = North Fork of the Middle Fork American Rive North Fork American River

[2]Universal Transverse Mercator Zone 10 North, North American Datum 1983

[3]See Map AQ 2-1

[4]Rosgen Level I is only available for Comparison Reaches

[5]S = Snorkel, E = E-fish

Table AQ 2-1. River Fish Population Study Site Locations and Sampling Reaches (Continued).

Study Sites[1]	Reach Type			Downstream Starting Location (UTM)[2]		Reach Name[3]	Rosgen Level I/II Channel Type[3]	Elevation (ft)	Site Length (ft)	Survey Date	Survey Method[4]	Study Reach Name and Description
	Peaking Reach	Bypass Reach	Reach Upstream of Project Facilities or Comparison Rivers	Easting	Northing							
South Fork Long Canyon Creek												
SFLC2.3			●	717834	4324157	SFLONG-R1	B	4514	555	Aug 28, 2007	E	South Fork Long Canyon Creek from Diversion confluence with Long Canyon Creek
SFLC4.2	●			720511	4326822	Comparison Reach	B3	4820	425	Aug 29, 2007	E	South Fork Long Canyon Creek upstream of Diversion
North Fork Long Canyon Creek												
NFLC1.9		●		716366	4324300	NFLONG-R1	B	4462	399	Aug 30, 2007	E	North Fork Long Canyon Creek from Diversion confluence with Long Canyon Creek
NFLC3.8			●	718022	4325797	Comparison Reach	B2-3	4859	431	Sep 5, 2007	E	North Fork Long Canyon Creek upstream of Di
Duncan Creek												
D6.3		●		715487	4332062	DUN-R2	B/F	4787	541	Sep 6, 2007	E	Duncan Creek from Diversion to confluence wi Middle Fork American River
D9.0			●	718147	4335162	Comparison River	B1-2	5338	457	Sep 7, 2007	E	Duncan Creek upstream of Diversion
North Fork of the Middle Fork American River												
NFMF2.3			●	697266	4321655	Comparison River	F2-3/B2-3	1263	818	Oct 1, 2007	S, E	North Fork of the Middle Fork American River n Circle Bridge
North Fork American River												
NF18.4	●			669483	4306278	Lower NF American River	F	509	4394	Oct 9, 2007	S	North Fork American River below the confluenc the Middle Fork American River
NF31.3			●	677360	4317941	Comparison River	F3-4	781	3195	Oct 4, 2007	S	North Fork American River above Lake Clemer
NF53.7			●	691800	4338960	Comparison River	unknown	1824	1823	Aug 31, 2007	S, E	Upper North Fork American River

[1]Site ID includes a river abbreviation and river mile location. MF= Middle Fork American River; R = Rubicon River; LC = Long Canyon Creek; SFLC = South Fork Long Canyon Creek; NFLC = North Fork Long Canyon Creek; D = Duncan Creek; NFMF = North Fork of the Middle Fork American River; North Fork American River

[3]See Map AQ 2-1

[4]Rosgen Level I is only available for Comparison Reaches

[5]S = Snorkel, E = E-fish

en Level Channel ype[4]	Elevation (ft)	Site Length (ft)	Survey Date	Survey Method[5]	Study Reach Description
F	643	3877	Oct 3, 2007	S	Middle Fork American River from confluence of Canyon Creek to confluence with North Fork American River
F	797	3374	Oct 2, 2007, Oct 16, 2007	S	Middle Fork American River from Ralston Afterbay to confluence with Canyon Creek
Bc/F	1188	971	Sep 18, 2007	S, E	Middle Fork American River from Middle Fork Interbay to Ralston Afterbay
la/Fb	2577	534	Sep 20, 2007	S, E	Middle Fork American River from confluence with Duncan Creek to Middle Fork Interbay
la/Fb	4505	710	Sep 26, 2007	S, E	Middle Fork American River from French Meadows to confluence with Duncan Creek
B3	5295	660	Oct 11, 2007	E	Middle Fork American River upstream of French Meadows Reservoir
Bc/F	1325	1427	Sep 17, 2007	S, E	Rubicon River from Long Canyon Creek Confluence to Ralston Afterbay
B/Fb	3350	1224	Sep 19, 2007	S, E	Rubicon River from Deer Creek to Long Canyon Creek Confluence
C	3927	413	Sep 25, 2007	S, E	Rubicon River from Hell Hole Reservoir to Deer Creek
B3	4800	688	Sep 27, 2007	E	Rubicon River upstream of Hell Hole Reservoir
F	3740	543	Oct 8, 2007	E	Long Canyon Creek from North and South Fork Long Canyon creeks confluence to confluence with Rubicon River

FLC = South Fork Long Canyon Creek; NFLC = North Fork Long Canyon Creek; D = Duncan Creek; NFMF = North Fork of the Middle Fork American River; NF =

en Level hannel ype[3]	Elevation (ft)	Site Length (ft)	Survey Date	Survey Method[4]	Study Reach Name and Description
B	4514	555	Aug 28, 2007	E	South Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
B3	4820	425	Aug 29, 2007	E	South Fork Long Canyon Creek upstream of Diversion
B	4462	399	Aug 30, 2007	E	North Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
2-3	4859	431	Sep 5, 2007	E	North Fork Long Canyon Creek upstream of Diversion
3/F	4787	541	Sep 6, 2007	E	Duncan Creek from Diversion to confluence with Middle Fork American River
1-2	5338	457	Sep 7, 2007	E	Duncan Creek upstream of Diversion
3/B2-3	1263	818	Oct 1, 2007	S, E	North Fork of the Middle Fork American River near Circle Bridge
F	509	4394	Oct 9, 2007	S	North Fork American River below the confluence with the Middle Fork American River
3-4	781	3195	Oct 4, 2007	S	North Fork American River above Lake Clementine
known	1824	1823	Aug 31, 2007	S, E	Upper North Fork American River

LC = South Fork Long Canyon Creek; NFLC = North Fork Long Canyon Creek; D = Duncan Creek; NFMF = North Fork of the Middle Fork American River; NF =

Table AQ 2-2. Reservoir and Diversion Pool Sampling Locations and Effort.

Study Reservoir or Diversion Pool	Number of Sampling Periods	Number of Fish Population Sampling Locations
Middle Fork American River		
French Meadows Reservoir	1	3[1]
Interbay Reservoir	1	3[1]
Ralston Afterbay Reservoir	1	3[1]
Rubicon River		
Hell Hole Reservoir	1	3[1]
Long Canyon Creek		
North Fork Long Canyon Creek Diversion Pool	1[2]	1
South Fork Long Canyon Creek Diversion Pool	1	1
Duncan Creek		
Duncan Creek Diversion Pool	2[3]	1

[1]Refers to the number of gillnetting locations in the reservoir

[2]Diversion Pool riverine

[3]Accurate population count was not possible due to storm events

Table AQ 2-3. Validity of Comparison Study Sites and their Associated Bypass and Peaking Reach Study Sites Based on Physical Habitat Characteristics.

Comparison Study Sites	Description	Peaking Reach	Bypass Reach	Comparison Site	Validity of Study Site Comparison		Rationale
					By Length	By Area	
Fish MF44.7	Middle Fork American River below French Meadows		●		Poor	Poor	Dissimilar channel type, slope, and pool depth. Similar wetted width.
Fish MF51.8	Middle Fork American River above French Meadows			●			
Fish R25.7	Rubicon River below Hell Hole		●		Poor	Poor	Dissimilar channel type, slope, wetted width, and pool depth.
Fish R36.2	Rubicon River above Hell Hole			●			
Fish NFLC1.9	North Fork Long Canyon Creek below diversion		●		Moderate	Moderate	Similar channel type, wetted width, and pool depth. Dissimilar slope.
Fish NFLC3.8	North Fork Long Canyon Creek above diversion			●			
Fish SFLC2.3	South Fork Long Canyon Creek below diversion		●		Good	Good	Similar channel type, slope, wetted width, and pool depth.
Fish SFLC4.2	South Fork Long Canyon Creek above diversion			●			
Fish D6.3	Duncan Creek below diversion		●		Good	Poor	Similar channel type, slope, and pool depth. Dissimilar wetted width.
Fish D9.0	Duncan Creek above diversion			●			
Fish MF4.8	Middle Fork American River above Mammoth Bar	●			Moderate	Moderate	Similar channel type and slope. Dissimilar wetted width and pool depth.
Fish NF31.3	North Fork American River at Ponderosa Bridge			●			
Fish MF14.1	Middle Fork American River at Otter Creek	●			Good	Good	Similar channel type, slope, wetted width, and pool depth.
Fish NF31.3	North Fork American River at Ponderosa Bridge			●			
Fish NF18.4	North Fork American River below Middle Fork American Confluence	●			Good	Good	Similar channel type, slope, wetted width, and pool depth.
Fish NF31.3	North Fork American River at Ponderosa Bridge			●			
Fish MF26.2	Middle Fork American River above Ralston		●		Good	Good	Similar channel type, slope, wetted width, and pool depth.
Fish NFMF2.3	North Fork Middle Fork American River at Circle Bridge			●			
Fish R3.5	Rubicon River at Long Canyon Creek		●		Good-Moderate	Good-Moderate	Similar channel type, wetted width, and pool depth. Moderatly dissimilar slope.
Fish NF53.7	Upper North Fork American River			●			
Fish R20.9	Rubicon River at Ellicott Bridge		●		Good-Moderate	Good-Moderate	Similar channel type, wetted width, and pool depth. Moderatly dissimilar slope.
Fish NF53.7	Upper North Fork American River			●			

Table AQ 2-4. Summary of Fish Species Observed during the 2007 Fish Population Sampling (●).

Study Site	DATE	Sample Type[1]	Fish Species[2]														
			RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	KOK	TCB	LKT	WCF
Middle Fork American River Downstream of Ralston Afterbay																	
Fish MF4.8	10/3/07	QUANT	●	●			●	●	●								
Fish MF4.8	10/3/07	QUAL				●		●	●								
Fish MF14.1	10/2/07	QUANT	●	●				●	●								
Otter Creek at MF14.1	10/2/07; 10/16/07	QUAL	●		●	●	●	●	●		●						
Gas Canyon	5/7/07	QUAL	●	●					●								
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay																	
Fish MF26.2	9/18/07	QUANT	●	●	●	●	●	●	●	●	●						
MFAR upstream of Ralston Afterbay	6/5/07; 6/25/07; 7/16/07	QUAL	●	●	●	●	●	●	●	●	●						
MFAR at RM29.4[3]	10/24/07	QUAL	●	●													
Middle Fork American River Upstream of Middle Fork Interbay																	
Fish MF36.2	9/21/07	QUANT	●	●													
Fish MF44.7	9/26/07	QUANT	●	●													
Fish MF51.8	10/11/07	QUANT	●	●													
Rubicon River																	
Rubicon River upstream of Ralston Powerhouse	5/11/07; 6/7/07; 6/27/07;7/17/07	QUAL	●		●	●	●	●	●	●	●						
Rubicon at RM3.5	6/12/07	QUAL			●												
Fish R3.5	9/17/07	QUANT	●	●		●	●	●	●	●	●						
Rubicon River at RM5.2	10/24/07	QUAL	●	●													
Rubicon River at RM9.9	9/27/2007	QUAL	●	●							●						
Rubicon River at RM14.3	9/27/2007	QUAL	●	●							●						
Fish R20.9	9/19/2007	QUANT	●	●													
Fish R25.7	9/25/07	QUANT	●	●													
Fish R36.2	9/27/07	QUANT	●	●						●							
Long Canyon Creek																	
Fish LC9.0	10/8/07	QUANT	●														
North Fork Long Canyon Creek																	
Fish NFLC1.9	8/30/07	QUANT	●														
Fish NFLC3.8	9/5/07	QUANT	●														
NFLC upstream of diversion pool	5/17/07; 6/16/07; 6/26/07	QUAL	●														

[1]QUAL = Qualitative Sampling (multi-pass electrofishing, multiple lane snorkeling, and gill netting); QUANT = Quantitative sampling (snorkeling, single pass electrofishing, or seining)

[2]Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pike Minnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SCULP = Sculpin; SD = Speckled Dace; CAR = California Roach; SMB = Smallmouth Bass; GSUN = Green Sunfish; KOK = Kokanee; TCB = Tui Chub; LKT = Lake Trout; WCF = White Catfish

[3]RM=River Mile

Table AQ 2-4. Summary of Fish Species Observed during the 2007 Fish Population Sampling (●) (continued).

Study Site	DATE	Sample Type[1]	Fish Species[2]														
			RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	KOK	TCB	LKT	WCF
South Fork Long Canyon Creek																	
Fish SFLC2.3	8/28/07	QUANT	●														
Fish SFLC4.2	8/29/07	QUANT	●														
SFLC upstream of diversion pool	5/17/07; 6/16/07; 6/26/07	QUAL	●														
Duncan Creek																	
Fish D6.3	9/6/07	QUANT	●	●													
Fish D9.0	9/7/07	QUANT	●	●													
Duncan Creek upstream of diversion pool	5/17/07; 6/16/07; 6/26/07	QUAL	●	●													
North Fork of the Middle Fork American River																	
Fish NFMF2.3	10/1/07	QUANT	●			●		●	●	●	●						
North Fork American River																	
Fish NF18.4	10/9/07	QUANT	●	●				●	●								
Fish NF31.3	10/21/07	QUANT	●			●	●	●	●			●	●				
NF at RM31.3	10/21/07	QUAL	●			●		●	●			●	●				●
Fish NF53.7	8/31/07	QUANT	●			●	●	●	●	●	●						
Diversion Pools																	
NFLC	9/4/07	QUANT	dry														
SFLC	9/4/07	QUANT	●														
Duncan	10/2/2007; 10/26/2007	QUANT	●	●													
Reservoirs																	
Ralston	9/13/07-9/14/07	Gillnetting	●	●	●	●		●									
Interbay	9/20/07-9/21/07	Gillnetting	●	●													
French Meadows	9/11/07-9/13/07	Gillnetting	●	●										●	●		
Hell Hole	9/10/07-9/12/07	Gillnetting	●	●				●						●	●	●	

[1]QUAL = Qualitative Sampling (multi-pass electrofishing, multiple lane snorkeling, and gill netting); QUANT = Quantitative sampling (snorkeling, single pass electrofishing, or seining)

[2]Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pike Minnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SCULP = Sculpin; SD = Speckled Dace; CAR = California Roach; SMB = Smallmouth Bass; GSUN = Green Sunfish; KOK = Kokanee; TCB = Tui Chub; LKT = Lake Trout; WCF = White Catfish

[3]RM = River Mile

Table AQ 2-5. Reservoir Gillnetting Catch and Catch Per Unit Effort (CPUE) for 2007 and for Historical Sampling Data.

Date	Total nets deployed	Total deployment hours	Average Hours per Net	Reservoir Totals		RBT[1]		RBT X CT		BNT		HH		SPM		SS		KOK		TCB		LK
				Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish	fish/hr	Total Fish
French Meadows Reservoir																						
9/11/2007	12	243.0	20.3	39	0.160	10	0.041			28	0.115							1	0.004			
8/21/1985	*	12.0	*	14	1.167	12	1.000			2	0.167											
6/2/1982	5	15.0	3.0	56	3.733	5	0.333			51	3.400											
5/24/1982	2	14.0	7.0	5	0.357	2	0.143			3												
9/16/1975	2	11.0	5.5	14	1.273	5	0.455			9	0.818											
Middle Fork Interbay																						
9/20/2007	4	80.0	20.0	29	0.363	13	0.163			16	0.200											
Ralston Afterbay																						
9/13/2007	6	110.7	18.4	120	1.084	6	0.054			10	0.090	6	0.054	5	0.045	93	0.840					
Hell Hole Reservoir																						
9/10/2007	10	194.5	19.4	134	0.689	0[2]	0.010			20	0.103					93	0.478	13	0.067	5	0.026	1
6/16/1983	3	54.0	18.0	332	6.148					9	0.167					219	4.056			104	1.926	
1/25/1978	2	30.8	15.4	455	14.797			3	0.098	10	0.325					41	1.333			401	13.041	
9/15/1975	2	11.0	5.5	6	0.545	1	0.091			4	0.364					1	0.091					
11/7/1974	2	14.0	7.0	91	6.500	2	0.143			7	0.500					62	4.429			20	1.429	
6/16/1971	6	81.0	13.5	791	9.765	5	0.062			19	0.235					228	2.815			539	6.654	
9/7/1967	2	12.0	6.0	95	7.917	2	0.167			1	0.083					88	7.333			4	0.333	
5/24/1966	1	12.0	12.0	25	2.083	10	0.833			2	0.167					13	1.083					

[1]Species: RBT = Rainbow Trout; CT = Cutthroat Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pike Minnow; SS = Sacramento Sucker; KOK = Kokanee; TCB = Tui Chub; LKT = Lake Trout

[2]One RBT captured during qualitative mercury sampling

KT
fish/hr
0.005

Table AQ 2-6. Density of Species, Fish per Mile, and Percent of Young-of-the-Year at Quantitative Sampling Sites.

Study Site	Species[1] Density (fish per mile)										
	RBT (% YOY)	BNT (% YOY)	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN
Middle Fork American River Downstream of Ralston Afterbay											
Fish MF4.8	142 (0%)	19 (0%)	--	--	1308	831	6.8	--	--	--	--
Fish MF14.1	307 (2%)	69 (0%)	--	--	--	3.1	7.8	--	--	--	--
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay											
Fish MF26.2	440 (14%)	16 (0%)	5.4	120	289	228	696	56	272	--	--
Middle Fork American River Upstream of Middle Fork Interbay											
Fish MF36.2	2511 (74%)	287 (85%)	--	--	--	--	--	--	--	--	--
Fish MF44.7	550 (44%)	714 (23%)	--	--	--	--	--	--	--	--	--
Fish MF51.8	2512 (92%)	2056 (99%)	--	--	--	--	--	--	--	--	--
Rubicon River											
Fish R3.5	200 (43%)	4 (0%)	--	41	5347	3.7	870	777	63	--	--
Fish R20.9	1402 (41%)	43 (30%)	--	--	--	--	--	--	--	--	--
Fish R25.7	1688 (60%)	256 (68%)	--	--	--	--	--	--	--	--	--
Fish R36.2	1435 (78%)	100 (92%)	--	--	--	--	--	--	--	--	--
Long Canyon Creek											
Fish LC9.0	6680 (88%)	--	--	--	--	--	--	--	--	--	--
North Fork Long Canyon Creek											
Fish NFLC1.9	4777 (61%)	--	--	--	--	--	--	--	--	--	--
Fish NFLC3.8	3504 (55%)	--	--	--	--	--	--	--	--	--	--
South Fork Long Canyon Creek											
Fish SFLC2.3	4386 (74%)	--	--	--	--	--	--	--	--	--	--
Fish SFLC4.2	4757 (71%)	--	--	--	--	--	--	--	--	--	--
Duncan Creek											
Fish D6.3	2264 (63%)	537 (75%)	--	--	--	--	--	--	--	--	--
Fish D9.0	2438 (60%)	139 (67%)	--	--	--	--	--	--	--	--	--
North Fork of the Middle Fork American River											
Fish NFMF2.3	710 (47%)	--	--	13	--	200	297	787	1704	--	--
North Fork American River											
Fish NF18.4	62 (0%)	1 (0%)	--	--	--	23	7.2	--	--	--	--
Fish NF31.3	5 (0%)	--	--	32	128	10	5.0	--	--	6.6	3.3
Fish NF53.7	403 (8%)	--	--	17	3224	226	14	75	104	--	--

[1]Species: RBT = Rainbow Trout, BNT = Brown Trout, HH = Hardhead, SPM = Sacramento Pike Minnow, MXD = Mixed Minnow, SS = Sacramento Sucker, SCULP = Sculpin, SD = Speckled Dace, CAR = California Roach, SMB = Smallmouth Bass, GSUN = Green Sunfish

Table AQ 2-7. Density of Species, Fish per Acre, and Percent of Young-of-the-Year at Quantitative Sampling Sites.

Study Site	Species[1] Density (fish per acre)										
	RBT (% YOY)	BNT (% YOY)	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN
Middle Fork American River Downstream of Ralston Afterbay											
Fish MF4.8	10 (0%)	1 (0%)	--	--	73	61	0.5	--	--	--	--
Fish MF14.1	24 (2%)	5 (0%)	--	--	--	0.2	0.6	--	--	--	--
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay											
Fish MF26.2	78 (14%)	3 (0%)	1.0	21	50	40	123	10	48	--	--
Middle Fork American River Upstream of Middle Fork Interbay											
Fish MF36.2	643 (74%)	73 (85%)	--	--	--	--	--	--	--	--	--
Fish MF44.7	124 (44%)	161 (23%)	--	--	--	--	--	--	--	--	--
Fish MF51.8	479 (92%)	392 (99%)	--	--	--	--	--	--	--	--	--
Rubicon River											
Fish R3.5	27 (43%)	1 (0%)	--	5.5	727	0.5	118	106	8.5	--	--
Fish R20.9	193 (41%)	6 (30%)	--	--	--	--	--	--	--	--	--
Fish R25.7	167 (60%)	25 (68%)	--	--	--	--	--	--	--	--	--
Fish R36.2	425 (78%)	30 (92%)	--	--	--	--	--	--	--	--	--
Long Canyon Creek											
Fish LC9.0	3392 (88%)	--	--	--	--	--	--	--	--	--	--
North Fork Long Canyon Creek											
Fish NFLC1.9	2990 (61%)	--	--	--	--	--	--	--	--	--	--
Fish NFLC3.8	2476 (55%)	--	--	--	--	--	--	--	--	--	--
South Fork Long Canyon Creek											
Fish SFLC2.3	2935 (74%)	--	--	--	--	--	--	--	--	--	--
Fish SFLC4.2	3703 (71%)	--	--	--	--	--	--	--	--	--	--
Duncan Creek											
Fish D6.3	487 (63%)	115 (75%)	--	--	--	--	--	--	--	--	--
Fish D9.0	947 (60%)	54 (67%)	--	--	--	--	--	--	--	--	--
North Fork of the Middle Fork American River											
Fish NFMF2.3	141 (47%)	--	--	3	--	40	59	156	339	--	--
North Fork American River											
Fish NF18.4	5 (0%)	0 (0%)	--	--	--	1.7	0.5	--	--	--	--
Fish NF31.3	0 (0%)	--	--	2.8	11	0.9	0.4	--	--	0.6	0.3
Fish NF53.7	50 (8%)	--	--	2.2	404	28	1.8	9.4	13	--	--

[1]Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pike Minnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SCULP = Sculpin; SD = Speckled Dace; CAR = California Roach; SMB = Smallmouth Bass; GSUN = Green Sunfish

Table AQ 2-8. Rainbow Trout and Brown Trout Biomass at Quantitative Study Sites.

Study Site	Pounds per Mile			Pounds per Acre		
	Total	RBT	BNT	Total	RBT	BNT
Middle Fork American River Downstream of Ralston Afterbay						
Fish MF4.8	116	87.1	29	8.5	6.4	2.1
Fish MF14.1	349	243	106	27	19	8.1
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay						
Fish MF26.2	81	65	16.0	14	12	2.8
Middle Fork American River Upstream of Middle Fork Interbay						
Fish MF36.2	164	142	22.0	42	36	5.6
Fish MF44.7	78	21.9	56	18	4.9	13
Fish MF51.8	36.5	19.6	17.0	7.0	3.7	3.2
Rubicon River						
Fish R3.5	53	46.7	6.3	7	6.4	0.9
Fish R20.9	156	140	15.2	21	19	2.1
Fish R25.7	230	217	12.7	23	21	1.3
Fish R36.2	46	45	1.0	14	13	0.3
Long Canyon Creek						
Fish LC9.0	136	136	0.0	69	69	0.0
North Fork Long Canyon Creek						
Fish NFLC1.9	113	113	0.0	71	71	0.0
Fish NFLC3.8	87	87	0.0	62	62	0.0
South Fork Long Canyon Creek						
Fish SFLC2.3	89	89	0.0	60	60	0.0
Fish SFLC4.2	79	79	0.0	61	61	0.0
Duncan Creek						
Fish D6.3	85	58	27.2	18	12	5.9
Fish D9.0	93	86	7.1	36	33	2.8
North Fork of the Middle Fork American River						
Fish NFMF2.3	63	63	0	12	12	0
North Fork American River						
Fish NF18.4	42.5	40.5	2.0	3.2	3.1	0.2
Fish NF31.3	1.5	1.5	0	0.1	0.1	0
Fish NF53.7	97	97	0	12	12	0

[1]Species: RBT = Rainbow Trout, BNT = Brown Trout

[2]Weights were estimated for fish observed by snorkeling from length/weight regressions

Table AQ 2-9. Rainbow Trout (RBT) and Brown Trout (BNT) Condition Factors.

Study River and Sample ID	RBT		BNT	
	Condition Factor	n	Condition Factor	n
Middle Fork American River Downstream of Ralston Afterbay				
Fish MF4.8	--	NA[1]	--	NA[1]
Fish MF14.1	1.01	10	--	NA[1]
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay				
Fish MF26.2	1.02	24	1.31	2
Middle Fork American River Upstream of Middle Fork Interbay				
Fish MF36.2	1.04	43	1.05	1
Fish MF44.7	1.06	5	1.07	25
Fish MF51.8	1.07	15	1.05	3
Rubicon River				
Fish R3.5	1.06	11	--	Not Observed
Fish R20.9	1.05	98	1.14	4
Fish R25.7	1.09	27	1.13	6
Fish R36.2	1.08	38	0.98	1
Long Canyon Creek				
Fish LC9.0	1.10	81	--	Not Observed
North Fork Long Canyon Creek				
Fish NFLC1.9	1.05	79	--	Not Observed
Fish NFLC3.8	1.04	113	--	Not Observed
South Fork Long Canyon Creek				
Fish SFLC2.3	1.09	46	--	Not Observed
Fish SFLC4.2	1.11	25	--	Not Observed
Duncan Creek				
Fish D6.3	1.11	83	1.07	13
Fish D9.0	1.16	82	1.06	3
North Fork of the Middle Fork American River				
Fish NFMF2.3	1.09	22	--	Not Observed
North Fork American River				
Fish NF18.4	--	NA[1]	--	NA[1]
Fish NF31.3	--	NA[1]	--	NA[1]
Fish NF53.7	1.10	16	--	Not Observed

[1]NA=snorkel only site, no weights were collected to calculate biomass

Table AQ 2-10. Snorkeling Versus Electrofishing Comparison in Run Mesohabitat Units.

Study Site	Electrofish Sample				Snorkel Sample (Percent Accuracy)			
	Adult Hardhead	Adult Pikeminnow	Adult Rainbow Trout	Adult Brown Trout	Adult Hardhead	Adult Pikeminnow	Adult Rainbow Trout	Adult Brown Trout
Middle Fork American River								
Fish MF26.2	0	0	7	1	0 (100%)	0 (100%)	3 (43%)	0 (0%)
Rubicon River								
Fish R3.5	0	0	0	0	0 (100%)	0 (100%)	0 (100%)	0 (100%)
North Fork American River								
Fish NF53.7	0	0	13	0	0 (100%)	0 (100%)	13 (100%)	0 (100%)

Table AQ 2-11. Results from Diversion Pool Fish Population Survey[1].

Date	RBT[2]				BNT				Unknown Trout	Notes
	YOY	3-6"	6-12"	12+"	YOY	3-6"	6-12"	12+"		
Duncan Creek Diversion Pool										
10/12/2007	--	--	--	--	--	--	--	--	--	Poor visibility. Not sampled.
10/26/2007	0	0	0	1	0	1	0	0	1 (12+")	Poor visibility. Accurate count was not possible.
North Fork Long Canyon Diversion Pool										
9/4/2007	--	--	--	--	--	--	--	--	--	Dry, no fish observed.
South Fork Long Canyon Diversion Pool										
9/4/2007	1	10	1	0	0	0	0	0	0	--

[1]All diversion pools were surveyed by snorkeling

[2]Species: RBT = Rainbow Trout; BNT = Brown Trout; YOY=Young-of-the-Year

Table AQ 2-12. Species and Life Stage Periodicities.

Species	Month											
Life Stage	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Rainbow Trout												
Spawning												
Incubation												
Fry												
Juvenile												
Adult												
Brown Trout												
Spawning												
Incubation												
Fry												
Juvenile												
Adult												
Sacramento Pike Minnow												
Spawning												
Incubation												
Fry												
Juvenile												
Adult												
Hardhead												
Spawning												
Fry												
Juvenile												
Adult												
California Roach												
Spawning												
Incubation												
Fry												
Juvenile												
Adult												
Sacramento Sucker												
Spawning												
Incubation												
Fry												
Juvenile												
Adult												
Speckled Dace												
Spawning												
Incubation												
Fry												
Juvenile												
Adult												
Foothill Yellow-Legged Frog												
Breeding												
Incubation												
Tadpoles												
Juvenile												
Adult												

FIGURES

MAPS

APPENDIX A

Fish Population Sampling Site Description

APPENDIX B

Reservoir Gill Netting Details and Maps

APPENDIX C

Qualitative Fish Population Sampling: Survey Notes from Sampling Upstream of Small Stream Diversion Structures and Spring Fry Sampling Results

APPENDIX D

Quantitative Fish Population Sampling Data

APPENDIX E

Length Frequency Histograms

