

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

***FINAL***

**AQ 2 – FISH POPULATION  
TECHNICAL STUDY REPORT 2007–2009**



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## 1.0 INTRODUCTION

This report describes the 2007, 2008, and 2009 results of fish population studies conducted by the Placer County Water Agency (PCWA) in accordance with the AQ 2 – Fish Population Technical Study Plan (AQ 2 – TSP). The AQ 2 – TSP 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 objective of the study is to document species composition, distribution, abundance, growth, condition factor, and age structure of fish in the bypass<sup>1</sup> and peaking<sup>2</sup> reaches associated with the MFP, as well as comparison reaches. In addition, the study characterizes fish populations in Project reservoirs and diversion pools (species composition, relative abundance, and fish size). Depending on site conditions, electrofishing, snorkeling, netting, or a combination of these methods was used to sample for fish.

A draft report of the first year sampling results (2007) was distributed to the Aquatic Technical Working Group (TWG) on March 11, 2008 for a 60-day comment period. The comment period ended on May 10, 2008. Comments were addressed in the final 2007 report which was distributed in July 2008 (PCWA 2008).

A draft report of the combined first year and second year sampling results (2007, 2008) was distributed to the Aquatic Technical Working Group (TWG) on March 27, 2009 for a 60-day comment period. The Comment Period ended on May 26, 2009. Comments were addressed in the final 2008 report, which was distributed in June 2009 (PCWA 2009).

The AQ 2 – TSP (PCWA 2007) specified both river and reservoir fish sampling to be conducted in 2007 and additional sampling in Ralston Afterbay to be conducted in 2008. In addition, the TSP established a contingency sampling protocol for multiple year river sampling:

- *The river study sites will be sampled in year one to identify the spatial distribution and abundance of fish species. After year one [2007], the TWG will review the data 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.*

After reviewing the 2007 study results, the Aquatic TWG identified several river study sites for sampling in 2008 to augment the 2007 river sampling data during the June 2, 2008 TWG meeting.

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<sup>1</sup>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.

<sup>2</sup>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.

After reviewing the 2007 and 2008 combined study results with the Aquatic TWG, PCWA proposed 2009 sampling be conducted upstream and downstream of the South Fork Long Canyon Diversion. The Aquatic TWG agreed, contingent upon the following: locations where limited hardhead adult fish were present during the 2007 and 2008 sampling would be considered potential hardhead habitat during flow negotiations (i.e., Middle Fork American River ca. ½-mile upstream of Ralston Afterbay, the lower Rubicon River, and the Middle Fork American River downstream of Ralston Afterbay). PCWA concurred with these stipulations.

The following report summarizes the 2007, 2008, and 2009 fish sampling results. The 2009 results have been combined with the 2007 and 2008 results and the discussion has been updated, as appropriate. The report includes a description of the study objectives, study implementation, extent of study area, study approach, and study 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.

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. A summary of the study elements that have been completed, outstanding study elements, and any deviations or proposed modifications to the AQ 2 – TSP are discussed in the following subsections.

### **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).

The following study elements were completed in the spring through fall of 2008:

- Sample fish populations in Ralston Afterbay in the summer and fall using variable mesh gill nets, electrofishing, and sonar;
- Sample 2008 river contingency sampling locations (determined in consultation with the TWG):
  - Revisit and sample 11 of the 2007 river fish population study sites (5 sites in bypass reaches, 2 sites in the peaking reach, and 4 sites in comparison reaches);
  - Sample three new river fish population study sites (1 site below the Duncan Creek Diversion, 1 site above the Duncan Creek Diversion, and 1 site in the Middle Fork American River peaking reach a short distance downstream from Ralston Afterbay); and
  - Qualitatively sample the peaking reach and bypass reaches in the MFP to identify the distribution of minnow species. Also, qualitatively sample locations in the comparison reaches (North Fork American and North Fork of the Middle Fork American rivers).

The following study elements were completed in the fall of 2009:

- Sample the 2009 river contingency sampling locations upstream and downstream of South Fork Long Canyon Diversion (determined in consultation with the TWG):

- Revisit and sample the two South Fork Long Canyon study sites (one site upstream and one site downstream of the diversion);
- Select and sample two new (additional) study sites on South Fork Long Canyon (one site upstream and one site downstream of the diversion).

### **3.2. DEVIATIONS FROM TECHNICAL STUDY PLAN**

There were no deviations from the AQ 2 – TSP.

### **3.3. OUTSTANDING STUDY ELEMENTS**

The following study element will be completed in early 2010.

- Identify appropriate fish standing crop comparison datasets in collaboration with the 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 provided in a memo to the Aquatic TWG.

### **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 (Map AQ 2-1). Field data were collected only in portions of the study area that were accessible.

## **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 determining fish distribution and 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 provided in Table AQ 2-1, Table AQ 2-2, and Map AQ 2-1. Appendix A includes representative pictures and descriptions of the quantitative river sampling sites.

### **5.1.1. Rivers**

River sampling sites (electrofishing and snorkeling) were at least 328 feet long (100 meters (m)). 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 nearly all of the quantitative sampling sites were determined in the field in coordination with the TWG in August 2007. Three new river sampling sites were selected in 2008 by PCWA in consultation with the TWG using the same procedures used in 2007 (D8.3, D9.0, MF23.5). Two new river sampling sites were selected in 2009 by PCWA in consultation with the TWG using the same procedures used in 2007 and 2008 (SFLC3.0, SFLC5.2). 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 (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 potential effects of fishing on fish population results. One possible exception was a historic CDFG site (R20.9) that was sampled just upstream of Ellicott Bridge (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, comparison study sites were, as much as possible, located in sections of river with similar physical habitat and similar sampling methods were used.

### **5.1.2. Reservoirs**

Project reservoirs (French Meadows, Hell Hole, Middle Fork Interbay, and Ralston Afterbay) were sampled at three locations along the length of each reservoir using variable mesh gill nets in 2007 (Appendix B Maps). Ralston Afterbay was also sampled in 2008 using gill nets, electrofishing, and sonar. Gill net, electrofishing, and sonar sampling location maps are presented in Appendix B. The small Project diversion pools (Duncan Creek, North and South Long Canyon Creek) were sampled in their entirety using snorkeling (2007).

## **5.2. RIVER AND STREAM SAMPLING**

River study sites were sampled in 2007, 2008, and 2009 to identify the spatial distribution and abundance of fish species (Table AQ 2-1 and Map AQ 2-1).

Quantitative river sampling using a combination of electrofishing (shallow water) and snorkeling (deep water) was conducted during the late summer/early fall base flow period (August 28 through October 11, 2007; September 9 through October 29, 2008; and October 5 through October 9, 2009) (Table AQ 2-1 and Map AQ 2-1).

### **5.2.1. Electrofishing**

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<sub>2</sub>), 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.

### **5.2.2. Snorkeling**

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. In 2007, fish were grouped into four size classes (0-3 in., 3-6 in., 6-12 in., >12 in.). The categories were based on the current CDFG Wild Trout sampling protocols (R. Bloom, Pers. Comm. 2007). In 2008, in consultation with the TWG, an additional size class was added to better identify the location and abundance of large fish (i.e., 0-3 in., 3-6 in., 6-12 in., 12-18 in., and >18+ in.). 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., <3 inches in size). Very small fish of all species that could not be identified were recorded as fry.

### **5.2.3. Snorkeling Efficiency and Accuracy**

In 2007, 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 (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.

#### **5.2.4. Qualitative Sampling**

In 2007, 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. In 2007 and 2008, qualitative snorkeling surveys were used to determine the summer/early fall distribution of hardhead between quantitative study sites on the Middle Fork American River and Rubicon River. In 2008, qualitative hardhead sampling was also completed at the Middle Fork American River peaking reach study sites and at two locations in two of the comparison rivers. The comparison river sites were the North Fork American River near Ponderosa Bridge and near Shirrtail Creek and the North Fork of the Middle Fork American River near the confluence with Middle Fork American River and near Circle Bridge.

### **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 fish size.

In 2008, Ralston Afterbay was sampled in the early summer and fall (June 26 and September 3-4) using variable mesh gill nets, electrofishing, and sonar. The purpose of the 2008 surveys was to understand (to the extent possible) the relative and absolute abundance of hardhead fry, juvenile, and adults compared to other species. Gill net sampling followed the same protocol used in 2007 and nets were generally deployed in the same locations (Appendix B, Map B1). Electrofishing was conducted from a CDFG electrofishing boat and focused on near-shore habitat (where electrofishing was effective). Eleven 100 meter sites that were evenly distributed along the banks of the reservoir were sampled (Appendix B, Table B-4, and Map B-5). To identify the most productive time period to sample, half of each site (50 meters) was sampled during the day and half at night during the early summer sampling period. The results from the summer sampling identified that night sampling was most productive and, therefore, the fall sampling was conducted at night. The electrofishing results were reported in fish per mile of shoreline, by species, and by size class.

Sonar sampling of Ralston Afterbay was conducted using a 3-dimensional Global Positioning System (GPS) enabled sonar unit (Humminbird 967c). Using the fish identifying function on the sonar unit, the number of fish and their depths were recorded

along transects on the latitudinal axis of the reservoir (Appendix B, Map B-6). The distance between transects was dictated by the depth and sonar beam coverage. The total number of fish by depth category (typically 5-foot depth increments) was estimated by dividing the number of fish observed in that depth range by the percentage of the reservoir in the depth category sampled. The volume sampled was calculated by computing the coverage of the sonar beam (beam angle and water depth) and the length of each transect in each depth category. Fish size could not be accurately discriminated using the single beam sonar.

#### **5.4. DIVERSION POOL SAMPLING**

The South Fork Long Canyon Diversion Pool and Duncan Creek Diversion Pool were snorkeled in September and October 2007. The number, species, and size of fish in the diversion pool were identified. In summer/fall 2007, the low level outlet of the North Fork Long Canyon Creek Diversion Pool was open, thereby eliminating water capture in the diversion pool. The resulting stream segment present within the footprint of the diversion pool was sampled (no fish were observed) (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:

##### Document Fry Emergence

- To collect seasonal information on emergence and relative abundance of trout fry (i.e., to identify timing of spawning and early fry rearing) upstream of 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.

##### Supplement the Age and Growth Study

- 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**

Information on historic fish distribution in the study area was summarized in the SD F of

the PAD based on a literature review (PCWA 2007). The current distribution of fish in the study area was based on results from the quantitative and qualitative fish population sampling. A current 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 based on the best available information, but fish of a particular species were not actually observed or there was no sampling to confirm their presence (e.g., inaccessible reach).

### **5.6.2. Fish Abundance (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 to estimate fish abundance.

### **5.6.3. Reach-Extrapolated Standing Crop**

In 2007, reach-extrapolated 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, then the reach-extrapolated 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, but 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 as the fish were categorized into fish size bins using visual estimates (underwater visual observations calibrated with a ruler).

### **5.6.5. Fish Population Comparisons**

Fish density and biomass was compared between the sampling sites upstream and downstream of the diversions (Duncan Creek, North Fork Long Canyon, and South Fork Long Canyon diversions), upstream and downstream of the large reservoirs (Hell Hole and French Meadows reservoirs), and between the peaking and bypass sites and the comparison river sites. 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 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 could 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) were considered valid for comparison of density and/or biomass per length of stream. Sites with the above characteristics and with similar wetted width were considered valid for density and/or biomass per area comparisons. For example, sample sites with large differences in the wetted stream width that were otherwise similar (mesohabitat type, slope, channel type) were ranked as good for fish density per mile comparisons, but poor for fish density per acre (area) comparisons. Comparison sites with substantially different slope, were ranked as poor for both fish density per mile and fish density per acre comparisons.

### **5.6.6. 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 frequency 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.

### **5.6.7. Growth Rates and Condition Factor**

Average growth rates by year class 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 using individual condition factors for adult trout at each site.

### **5.6.8. 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.

### **5.6.9. 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.

### **5.6.10. Electronic Database**

An electronic database (Excel spreadsheet) of all the fish sampling data (date, location, fish species, fish size, sampling pass, etc) is available upon request.

## **6.0 RESULTS**

### **6.1. HISTORIC FISH DISTRIBUTION**

Some limited information was available on the historic fish distribution in the study rivers. SD F (Section 6.0, Fish and Aquatic Resources) 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., USDA-FS watershed assessment documents) and little primary source data was found (e.g., sampling records).

### **6.2. CURRENT FISH DISTRIBUTION AND DIVERSITY**

#### **6.2.1. Rivers and Streams**

***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 upstream of 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. The majority of the hardhead were found in Ralston Afterbay and the Middle Fork American and Rubicon rivers immediately upstream of Ralston Afterbay. Hardhead were also found in two isolated locations in the peaking reach downstream of Ralston Afterbay—a pool in Otter Creek at its confluence with the Middle Fork American River and an in-channel dredging pool in the Middle Fork American River at RM23.5 (upstream of Tunnel Chute). Young mixed minnows (<3 in.) were observed during snorkeling at several other locations, but they were too small to differentiate between hardhead and 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.

Qualitative snorkeling during the summer and fall of 2007 and 2008 was used to determine the minnow distribution (hardhead, Sacramento pikeminnow, and California roach) in the rivers upstream of Ralston Afterbay. Table AQ 2-4 shows the sampling locations. In the Middle Fork American River, minnows were only observed from Ralston Afterbay upstream 0.5 miles to the first major barrier. No minnows were found upstream of the barrier. In the Rubicon River, a large impassable barrier at RM6.0 appeared to limit the upstream distribution of hardhead (5.4 miles upstream of Ralston Afterbay) and a large impassable barrier at RM8.2 appeared to limit the upstream distribution of Sacramento pikeminnow (7.6 miles upstream of Ralston Afterbay). California roach were found as far upstream as RM14.3. No sampling occurred between RM14.3 and RM20.9 and California roach were not found at RM20.9 or the site upstream, RM25.7. In both the Middle Fork American and Rubicon rivers, hardhead and Sacramento pikeminnow presence was patchy, and the number of hardhead relative to other minnow species was low.

In the comparison rivers, hardhead and Sacramento pikeminnow presence was also patchy. At the North Fork American River site at RM31.3 downstream of Ponderosa Bridge, only one pool at the very bottom and one pool at the very top of the 1.3-mile snorkeling site contained hardhead or Sacramento pikeminnow. At the qualitative snorkeling site upstream at RM36 near Shirttail Creek and Bunch Canyon (approximately 1 mile long), a small side pool at the confluence with Bunch Canyon was the only location that contained hardhead and/or Sacramento pikeminnow. In the North Fork of the Middle Fork American River, hardhead and Sacramento pikeminnow were only found in the lower snorkeling sight near the confluence with the Middle Fork American River. Hardhead were not observed farther upstream at the Circle Bridge snorkeling site, RM2.3, but a few (six) small, Sacramento pikeminnow were observed.

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 and Appendix C). The primary factor limiting the upstream fish distributions was insufficient flow to maintain a connected channel. Brown and rainbow trout were found 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. Sampling extended beyond the last fish observations until there was no possibility of finding additional fish (e.g., no water deep enough to hold fish).

Sacramento sucker and sculpin were the most widely distributed species other than trout. They were found together in the same sampling locations including 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 North Fork American River upstream of 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 upstream of Middle Fork Interbay and in Duncan Creek (rainbow trout and brown trout) and in Long Canyon creeks (rainbow trout only).

### **6.2.2. Reservoirs**

All of the reservoirs contained rainbow and brown trout (Table AQ 2-5 and Appendix B, Table AQ B-2). Hell Hole Reservoir had the greatest species diversity with four additional species (six total), including lake trout, kokanee salmon, Tui chub, and Sacramento sucker. In French Meadows Reservoir two additional species were captured, Tui chub and kokanee salmon (four species total). Only one kokanee salmon was captured and it was likely an anomaly as no known kokanee stocking has occurred in French Meadows Reservoir. Ralston Afterbay contained hardhead, Sacramento pikeminnow, and Sacramento sucker in addition to rainbow and brown trout. Only rainbow and brown trout were captured in Middle Fork Interbay.

Historical fish sampling data from the Project reservoirs is provided in Table AQ 2-5. Lake trout and kokanee salmon were not recorded in the historical sampling data. Both species, however, are known to exist in Hell Hole Reservoir. Lake trout were historically stocked and currently are self-sustaining. Kokanee salmon are stocked annually in Hell Hole Reservoir. In the 2007 sampling, kokanee salmon 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 or 2008. One kokanee salmon was captured in French Meadows Reservoir in 2007 and is believed to be an anomaly (there has been no management for kokanee salmon in French Meadows Reservoir).

### **6.3. FISH ABUNDANCE (STANDING CROP)**

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 Table AQ 2-6 and Table AQ 2-7, respectively, and in Figure AQ 2-3a and Figure AQ 2-3b. Reach-extrapolated 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.

### **6.3.1. Rivers and Streams – Trout**

Trout density was greatly affected by the number of YOY present. Generally, the small streams had the highest trout density, intermediate-sized streams/rivers had intermediate density, and the largest rivers had the lowest density. The highest linear trout densities (3,500–6,500 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 upstream of French Meadows Reservoir. Intermediate densities (800–3,500 trout per mile) were observed in Duncan Creek, the Middle Fork American River between Middle Fork Interbay and French Meadows Reservoir, and the upper Rubicon River (although fish per mile at the Ellicott Bridge site (RM20.9) was slightly less than 800 in 2008). The lowest densities (<800 trout per mile) were found in the comparison river sites (North Fork American River and North Fork of the Middle Fork American River), 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. The primary difference was that density per acre in large river sites with wide channels (e.g., R20.9) was comparatively lower relative to density per acre in small river sites with narrower channels (e.g., SFLC4.2) (i.e., density per acre has a negative relationship to channel width).

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 (sampled only in 2007). 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 (sampled only in 2007), and in 2007 the Rubicon River from Ellicott Bridge upstream. Comparatively, low densities of YOY trout were found in the comparison river sites (North Fork American River and North Fork of the Middle Fork American River), in the sampling sites just upstream of Ralston Afterbay (Rubicon River and Middle Fork American River), in 2008 the Rubicon River near Ellicott Bridge, and in the peaking reach.

***Reach-Extrapolated Standing Crop Estimates (2007 data only)*** – Generally, there was little difference in the results between the site-specific density estimates and the reach-extrapolated 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-extrapolated 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 downstream of 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 sampled similar to the proportion in the reach, but the sampled pools were very wide and, based on area, made up a larger percent of the habitat than was in the reach. 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 site-specific study site results produced similar density estimates to the reach-extrapolated results because the sampling effort in this study (i.e., mesohabitat sampled approximately in proportion to the percentage in the reach), generally controlled for the effects of mesohabitat types on density estimates.

### **6.3.2. Reservoirs – All Species**

The reservoirs include French Meadows, Hell Hole, Middle Fork Interbay, and Ralston Afterbay.

**All Reservoirs (2007 Gill Netting)** – Brown trout and rainbow trout were common (typically >0.1 fish/net hour combined), except that there were very few rainbow trout in Hell Hole Reservoir. Only one rainbow trout was captured in the quantitative and qualitative gill netting at Hell Hole Reservoir. Sacramento sucker was the most abundant species in Hell Hole Reservoir and Ralston Afterbay (>0.45 fish/net hour). Kokanee salmon were common (>0.06 fish/net hour) in Hell Hole Reservoir (Figure AQ 2-5, Table AQ 2-5). Other species, when observed (hardhead, Sacramento pikeminnow, Tui Chub, and lake trout), were typically captured in lower abundance. Historical gill net sampling (1966-1985) generally indicated 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 based on the historical gill netting efforts. The available stocking data for the reservoirs is provided in SD F (Section 6.0, Fish and Aquatic Resources) of the PAD (PCWA 2007).

**Ralston Afterbay (2008 Sampling)** – Ralston Afterbay sonar sampling produced an estimate of 11,128 fish (fish species could not be determined using sonar) during the early summer sampling and 12,128 fish during the fall sampling (Table AQ 2-8). The majority of the fish were in shallow water (90% ≤10 feet depth). The early summer

sampling did not include a small portion of Ralston Afterbay near the dam (portion between the log boom and the dam).

Shoreline electrofishing densities of hardhead and Sacramento pikeminnow were greater than 100 fish per mile (107 to 121) for each species during both the early summer and fall electrofishing sampling (Table AQ 2-9). Sacramento sucker density was 135 fish per mile and 68 fish per mile during the early summer and fall sampling period, respectively. Trout density (brown trout and rainbow trout combined) was less than 20 fish per mile during both early summer and fall sampling. The total amount of Ralston Afterbay shoreline was 3 miles.

Gill netting CPUE for all species combined in Ralston Afterbay was 0.56-0.86 fish/hour (Table AQ 2-5). Hardhead constituted 3% of the catch. Seventy-seven percent of the fish captured during the combined gill net sampling (including 2007) were large (13-22 inches (325-555 mm)) Sacramento sucker (Figure AQ 2-5, Figure AQ 2-6, and Appendix B, Table B-2). The remainder of the fish captured were rainbow trout (8%), brown trout (8%) and Sacramento pikeminnow (3%).

Potential electrofishing and gill netting gear sampling biases, both in terms of fish size and water sampling depth, made it difficult to definitively determine either the total abundance or percentage of different species or fish sizes in Ralston Afterbay. Electrofishing is primarily applicable only to shoreline habitat and is less effective on very small fish. Shoreline electrofishing collected primarily small, 3-6 inch (80-150 mm), hardhead, Sacramento pikeminnow, and Sacramento sucker and some larger 16<sup>+</sup> inch (>400 mm) Sacramento sucker and brown trout (Table AQ 2-9 and Figure AQ 2-6). Very small YOY fish <3 inches (<80 mm), if present, were not sampled in the electrofishing. Gill netting primarily sampled only deep (> 3 feet) open water habitat. Only fish greater than about 9 inches (>230 mm) were captured in the nets even though variable sized mesh was used. Very small YOY fish and medium sized fish, 6-16 inch (150 to 400 mm) sized fish were not present or were in low abundance in the combined electrofishing and gill netting sample results (Figure AQ 2-6). Whether this was the result of gear sampling biases, or not, is unknown.

### **6.3.3. Diversion Pools**

Eleven rainbow trout were observed in the South Fork Long Canyon Creek Diversion Pool during September 2007 snorkeling surveys (Table AQ 2-10). No fish were observed in the North Fork Long Canyon Diversion Pool. 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.

### **6.3.4. River, Streams and Reservoirs - Hardhead/Pikeminnow**

Based on the fish population sampling results, hardhead, particularly adults, were present in relatively low abundance in the study area. A total of 127 hardhead were

captured in 2007 and 2008 at the river and reservoir quantitative sampling sites (Table AQ 2-9 and Appendix D, Table AQ D-1). Nearly 90% (111) of these hardhead were small fish less than 6 inches. Over 95% (121) of the total number of fish captured were from Ralston Afterbay (112 from electrofishing, 9 from gill netting). The remainder of the headhead were captured in the Middle Fork American River upstream of Ralston Afterbay. In contrast, over 7,000 rainbow trout were observed (electrofishing and snorkeling surveys) at the same quantitative sampling sites over the same time period.

During 2007 qualitative sampling, a number of additional hardhead were captured. Seventy-eight hardhead were captured in spring/early summer in the Middle Fork American and Rubicon rivers just upstream of Ralston Afterbay. Most of these fish were small; the largest was 5.4 inches (138 mm). Also, it is likely that some young hardhead were present as part of the small mixed minnow fish guild that was counted during snorkeling in the comparison river sites and in the peaking reach (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.

The 2008 Ralston Afterbay sampling was primarily conducted to understand the relative abundance of hardhead fry, juveniles, and adults. Juvenile and adult hardhead were present in the reservoir. Potential size selectivity of the shoreline reservoir electrofishing left uncertainty, however, regarding the presence of YOY fry in the reservoir. The percentage of the Ralston Afterbay fish population that was hardhead is also uncertain due to potential size-related and habitat-related selectivity of the electrofishing and gill net sampling. Figure AQ 2-7a shows the electrofishing abundance and size class results for early summer and fall 2008; Figure AQ 2-7b shows the combined electrofishing and gill netting data

Sacramento pikeminnow were slightly more abundant in the Project area than hardhead, but adult fish were also relatively rare. A total of only 217 pikeminnow were captured or large enough to positively identify at the quantitative sampling sites (2007 and 2008). Over half (123) of these fish were captured in Ralston Afterbay (113 of which were less than 6 in.) and the remainder were captured in the river sites (MF26.2, R3.5, NFMF2.3, NF31.3, and NF53.7).

A total of 213 pikeminnow were captured during the 2007 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-3). These were young fish (largest was 3.8 in. (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 minnows observed that likely consisted largely of pikeminnow (Table AQ 2-4 and Appendix D, Table D-1).

#### **6.4. TROUT BIOMASS**

At any given site, trout biomass varied depending on whether it was evaluated linearly (pounds per mile) or on an area basis (pounds per acre) (Figure AQ 2-3a, Figure AQ 2-

3b, and Table AQ 2-11). Linear biomass was highest (>150 lbs/mile) at several of the large river bypass and peaking reach sites (e.g., MF14.1, MF23.5, and R25.7). On an area basis, biomass was highest at the small stream sites, Long Canyon creeks and Duncan Creek (>50 lbs/acre). The high biomass large river sites (e.g., MF14.1 and MF23.5) were composed primarily of relative fewer, but larger fish, while the high biomass small stream sites were composed primarily of relatively more, but smaller 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 relatively high at this location (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 upstream of 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 upstream of French Meadows Reservoir) was wide, shallow, and had low flow and relatively warm water temperatures. This site was dominated by YOY.

## **6.5. FISH POPULATION COMPARISONS**

Overall, fish abundance and standing crop were similar between the study sites in the bypass and peaking reaches and the comparison sites. The upstream and downstream diversion comparison sites were very similar based on linear fish density (fish/mile) and 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, MF14.1, and MF23.5) had lower trout density and biomass than the peaking reach sites. Water temperature was higher in the North Fork American River relative to the peaking reach. The density of other species at this comparison river site was relatively low as well. Tables AQ 2-6, AQ 2-7, and AQ 2-11 show the comparisons of fish density and biomass between the study sites and the comparison sites. Figures AQ 2-8a, AQ 2-8b, AQ 2-8c, AQ 2-9a, and AQ 2-9b 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. 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.

### **6.5.1. Upstream and Downstream Diversion Sites**

***South Fork Long Canyon Diversion*** – The linear trout density and biomass metrics

were similar upstream (SFLC4.2) and downstream (SFLC2.3) of the South Fork Long Canyon Diversion during 2007, 2008, and 2009 (Figures AQ 2-8a, AQ 2-8b, AQ 2-8c). The number of trout per mile and trout biomass per mile at the study sites downstream of the diversion were slightly higher in 2007, slightly lower in 2008, and similar in 2009 compared to the trout number/biomass per mile at the study sites upstream of the diversion. Trout density and biomass per acre was similar, perhaps slightly lower, downstream of the diversion compared to upstream of the diversion in 2007 and 2009 and lower downstream of the diversion in 2008 (Figures AQ 2-8a, AQ 2-8b, AQ 2-8c).

The biomass per acre was lower downstream of the diversion compared to upstream partly because the channel was wider downstream (similar biomass per length of stream, but somewhat different biomass per area of stream). For example, the study sites downstream of the diversion in 2009 averaged 79 ft wide versus 66 ft wide for the study sites upstream of the diversion.

There was variability in the average weight of fish downstream versus upstream of the diversion. In 2007 the average weight of fish downstream was greater than upstream, 9 g versus 8 g upstream, but in 2008 and 2009, the average weight of fish was slightly less downstream of the diversion (9 g versus 12 g in 2008 and 15 g versus 17 g in 2009). Note that the average fish size in 2009 at both the upstream and downstream sites was higher than in previous years because there were fewer YOY (small fish) in 2009 and, therefore, the average fish size was larger.

The sampling sites upstream and downstream of the diversion were generally physically similar except that the channel was a slightly narrower and steeper gradient upstream of the diversion (Table AQ 2-3 and Appendix A, Table A-3). Issues related to natural drying of the channel that occurs during the summer and fall upstream of the diversion and immediately downstream of sampling site SFLC4.2 may confound interpretation of the data at this study site (e.g., crowding of fish into the study site).

**North Fork Long Canyon Diversion** – Trout density and biomass were slightly lower upstream (NFLC3.8) of the diversion than downstream (NFLC1.9) (sites sampled only in 2007). The average fish weight was the same at the two sites (11g). 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 density and biomass were similar upstream (D9.0 and D10.0) and downstream (D6.3 and D8.3) of the diversion. In 2007, only the D9.0 and D6.3 sites were sampled. In 2007, all metrics (density and biomass) were higher downstream of the diversion. This same trend was generally true in 2008 when four sites were sampled. The only exception was that trout biomass per area in 2008 was slightly higher at D10.0 than D6.3. This difference was mainly due to trout at D10.0 having a higher average weight than trout at D6.3. In terms of physical site comparability, the Duncan Creek sites were similar except for D10.0, which was the farthest upstream. At this location, the valley type was narrower, the stream order was

lower, and channel slope was steeper than the other study sites. Therefore, D10.0 was ranked as poor for physical comparison purposes.

An error was found in the 2007 Fish Population Study report (PCWA 2008) calculations for the study site downstream of the Duncan Creek Diversion site (D6.3) that was corrected in this report. The width of one of the pool habitat units was improperly recorded on the data sheet as 171 feet instead of 17 feet. The error was identified during resampling of the same habitat unit in 2008.

### **6.5.2. Upstream and Downstream Reservoir Sites**

Physical channel habitat at the sampling sites upstream and downstream of French Meadows Reservoir and upstream and downstream of Hell Hole 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 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, pool depth, and water temperature were dissimilar upstream and downstream of 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). Upstream of the reservoir, the majority of the population was YOY; downstream of the reservoir, more adults were present, particularly in the deep pools sampled by snorkeling. Channel type, slope, wetted width, and pool depth were dissimilar upstream and downstream of the reservoir (Table AQ 2-3).

### **6.5.3. Peaking and Bypass Sites versus Comparison River 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). Water temperature was higher at the comparison site (NFMF2.3) (Map AQ 2-2). In terms of adult trout, the two sites had similar densities (per mile and acre); however, the NFMF2.3 site had more YOY fish. In 2007 biomass was higher in the bypass site (MF26.2) because the average size of the fish at MF26.2 was higher. In 2008, the trend was reversed (biomass was higher in the comparison site). This result was largely due to fewer, but

larger fish observed at NFMF2.3 during snorkeling surveys and smaller trout captured at MF26.2 during electrofishing. 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 was substantially higher than that at the NF53.7 comparison site. In 2007, biomass (both per mile and acre) was comparatively higher at the R20.9 site; however, in 2008 it was slightly lower. The change was mainly due to fewer large trout observed during snorkeling at R20.9 in 2008. 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 most of the sites in the peaking reach (MF4.8, MF14.1, and NF18.4), except for the upstream-most site (MF23.5) (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 in 2007. The peaking reach sites had many more trout (rainbow and brown trout). At the Ponderosa Bridge site (NF31.3) the water temperature was relatively 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 comparison site had young mixed minnows, smallmouth bass, and green sunfish. Smallmouth bass and green sunfish were not observed in the peaking reach sites and few young mixed minnows were present in the peaking reach.

## **6.6. FISH SIZE, AGE, GROWTH, AND CONDITION FACTOR**

### **6.6.1. Trout and Kokanee**

Trout throughout the study area rivers/streams were relatively small. In the small streams (Duncan Creek and the Long Canyon creeks), most fish were less than approximately 9.1 inches (230 mm) (Figure AQ 2-10a and Figure AQ 2-10b). The largest trout were observed in the pools of the large rivers (snorkeling); however, even in the large rivers most fish were less than 12 inches (305 mm). The study sites with the largest number and percentage of trout greater than 12 inches (305 mm) were the peaking reach study sites (NF 18.4, MF4.8, MF14.1, and MF23.5). In 2008, size classes during snorkeling surveys were adjusted to include a category for fish greater than 18 inches (457 mm). At each of the peaking reach sites sampled in 2008 (MF4.8, MF14.1, and MF23.5), trout of this size were observed; however, the majority of the 18<sup>+</sup>

inch fish were observed at the farthest upstream site, MF23.5 (nearly 75%). The length frequency histograms for each river site sampled in 2007 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 (Figure AQ 2-11). 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 in Hell Hole Reservoir captured in the gill nets ranged from about 300 to 420 mm (Figure AQ 2-12).

An analysis of age and growth for rainbow trout (age measured from scales) captured in 2007 showed variability in age structure and growth rate between sampling sites (Figure AQ 2-13). 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 2-13). 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 in 2007 and 1.1 in 2008 (Table AQ 2-12). 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 2007 and 2008 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 quality regression or if the size range of fish captured during electrofishing was limited, a general study site regression was developed (i.e., all measured fish from the study were combined).

### **6.6.2. Hardhead and Sacramento Pikeminnow**

Few adult hardhead or Sacramento pikeminnow were observed or captured (Section 6.3.4). Hardhead ranged in size from 35-471 mm. Sacramento pikeminnow ranged in size from 25-445 mm. The largest fish of both species were collected from Ralston Afterbay. The five largest hardhead captured in 2007 (347-471 mm) were aged using scale samples. They ranged from 4+ to 8+ years old. The three largest pikeminnow captured in 2007 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 of 2007 between 57-149 mm were aged. The fish greater than approximately 100 mm were 1+ and those less than approximately 100 mm were age 0+.

### **6.7. TIMING OF FRY EMERGENCE**

Spring and early summer qualitative sampling data from 2007 are shown in Figure AQ 2-14 and Appendix C, Table C-3 for each of the qualitative study sites.

#### **6.7.1. Rainbow and Brown Trout Fry**

Rainbow trout YOY were observed by the end of June 2007 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 during the first sampling date, May 11<sup>th</sup>, 2007 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 upstream of the diversion in early June 2007 (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 upstream of 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 approximately 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.

#### **6.7.2. Hardhead-Pikeminnow-Sucker Fry**

Based on the literature (Moyle 2002), it appears that hardhead mainly spawn in April and May, but spawning may extend into August. YOY fish typically reach 60-80 mm SL by the end of their first growing season. Our 2007 qualitative sampling in the Rubicon River upstream of Ralston Afterbay found hardhead (and Sacramento pikeminnow) as small as about 30 mm in early May and smaller 8-19 mm mixed minnows (too small for us to identify to species and could include Sacramento pikeminnow and California roach) in early June. It was difficult to determine if the 30 mm fish in early May were from the previous year (1+) or spawned early enough in the spring of 2008 to have grown to 30 mm by May. Minnow data collected on the Middle Fork American River

upstream of Ralston Afterbay did not help illuminate the issue. Our current assumption is that hardhead may be spawning from early April into the summer.

Small Sacramento pikeminnow (22–28 mm) were captured in the Middle Fork American and Rubicon rivers upstream of Ralston Afterbay in the early June sampling (June 5-7, 2007). Our assumption is that these were YOY fish. In this case, Sacramento pikeminnow would have been spawning in April-May consistent with the existing literature (Moyle 2002). Sacramento sucker were observed actively spawning in the Rubicon River immediately upstream of Ralston Afterbay on May 11<sup>th</sup>, 2007. Sacramento sucker YOY were first captured approximately 2 months later (July 16<sup>th</sup>) in a different sampling location (Middle Fork American River immediately upstream of Ralston Afterbay).

### **6.8. SNORKELING EFFICIENCY AND ACCURACY**

The comparison of electrofishing and snorkeling results in 2007 were similar for two of the three sites in regard to number of fish estimated and identification of adult fish (Table AQ 2-13). At one run habitat site with large substrate, the snorkel count was lower for adult trout compared to electrofishing data.

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). Therefore, meaningful comparisons regarding fish numbers estimated or species identification using the two different sampling techniques could not be made.

### **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 obtained for Moyle (2002), and general biological knowledge (Table AQ 2-14).

### **6.10. WATER TEMPERATURE**

The spatial pattern of average August water temperature indicates that most of the bypass reaches and peaking reach provide habitat for trout (e.g., average monthly water temperature <70°F) (Map AQ 2-2 and Appendix A, Table A-2) (Hokanson et al. 1977). The only bypass reach locations where average water temperature was 70°F or greater were the lower Rubicon River and lower Long Canyon Creek<sup>3</sup>. Comparison streams with warm water temperatures (e.g., greater than 70°F monthly average) 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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<sup>3</sup>The MFP does not affect flows during the summer and fall and, thus, does not affect water temperatures in Long Canyon Creek during the summer and fall.

## 7.0 REFERENCES

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### Personal Communication

CDFG. July 2007. Roger Bloom.

**TABLES**

**Table AQ 2-1. 2007-2009 River Fish Population Study Site Locations and Sampling Reaches.**

Study Sites <sup>1</sup>	Reach Type			Downstream Starting Location (UTM) <sup>2</sup>		Reach Name <sup>3</sup>	Rosgen Level I/II Channel Type <sup>4</sup>	Elevation (ft)	2007 Site Length (ft)	2008 Site Length (ft)	2009 Site Length (ft)	Survey Date	Survey Method <sup>5</sup>	Study Reach Description
	Peaking Reach	Bypass Reach	Reach Upstream of Project Facilities or Comparison Rivers	Easting	Northing									
<b>Middle Fork American River Downstream of Ralston Afterbay</b>														
MF4.8	●			675208	4310856	MFAR-R1	F	643	3877	3877	NA	10/3/07, 9/29/08	S	Middle Fork American River from confluence of Canyon Creek to confluence with North Fork American River
MF14.1	●			685474	4313591	MFAR-R3	F	797	3374	3374	NA	10/2/07, 10/16/07, 9/30/08	S	Middle Fork American River from Volcano Canyon Creek confluence to Canyon Creek confluence
MF23.5	●			694556	4319766	MFAR-R3	F	1066	NA	3531	NA	10/08/08	S	Middle Fork American River from Ralston Afterbay to Volcano Canyon Creek confluence
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>														
MF26.2		●		696565	4320226	MFAR-R4	Bc/F	1188	971	980	NA	9/18/07, 9/15/08	S, E	Middle Fork American River from Middle Fork Interbay to Ralston Afterbay
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>														
MF36.2		●		708258	4322377	MFAR-R5	Ba/Fb	2577	534	NA	NA	9/20/07	S, E	Middle Fork American River from confluence with Duncan Creek to Middle Fork Interbay
MF44.7		●		716691	4330009	MFAR-R5	Ba/Fb	4505	710	630	NA	9/26/07, 10/27/08	S, E	Middle Fork American River from French Meadows to confluence with Duncan Creek
MF51.8			●	723863	4335353	Comparison Reach	B3	5295	660	NA	NA	10/11/07	E	Middle Fork American River upstream of French Meadows Reservoir
<b>Rubicon River</b>														
R3.5		●		699586	4317545	RUB-R1	Bc/F	1325	1427	NA	NA	9/17/07	S, E	Rubicon River from Long Canyon Creek confluence to Ralston Afterbay
R20.9		●		717835	4315183	RUB-R2	B/Fb	3350	1224	1240	NA	9/19/07, 9/26/08	S, E	Rubicon River from Deer Creek to Long Canyon Creek confluence
R25.7		●		720929	4320677	RUB-R3	C	3927	413	NA	NA	9/25/07	S, E	Rubicon River from Hell Hole Reservoir to Deer Creek
R36.2			●	731393	4328025	Comparison Reach	B3	4800	688	NA	NA	9/27/07	E	Rubicon River upstream of Hell Hole Reservoir
<b>Long Canyon Creek</b>														
LC9.0		●		712179	4319355	LONG-R2	F	3740	543	NA	NA	10/8/07	E	Long Canyon Creek from North and South Fork Long Canyon creeks confluence to confluence with Rubicon River
<b>South Fork Long Canyon Creek</b>														
SFLC2.3		●		717834	4324157	SFLONG-R1	B	4514	555	560	562	8/28/07, 9/9/08, 10/5/09	E	South Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
SFLC3.0		●		718639	4325128	SFLONG-R1	B	4585	NA	NA	505	10/6/09	E	South Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
SFLC4.2			●	720511	4326822	Comparison Reach	B3	4820	425	476	478	8/29/07, 9/10/08, 10/7/09	E	South Fork Long Canyon Creek upstream of Diversion
SFLC5.2			●	721188	4327304	Comparison Reach	B3	4965	NA	NA	435	10/8/09	E	South Fork Long Canyon Creek upstream of Diversion

**Table AQ 2-1. 2007-2009 River Fish Population Study Site Locations and Sampling Reaches (continued).**

Study Sites <sup>1</sup>	Reach Type			Downstream Starting Location (UTM) <sup>2</sup>		Reach Name <sup>3</sup>	Rosgen Level I/II Channel Type <sup>4</sup>	Elevation (ft)	2007 Site Length (ft)	2008 Site Length (ft)	2009 Site Length (ft)	Survey Date	Survey Method <sup>5</sup>	Study Reach Name and Description
	Peaking Reach	Bypass Reach	Reach Upstream of Project Facilities or Comparison Rivers	Easting	Northing									
<b>North Fork Long Canyon Creek</b>														
NFLC1.9		●		716366	4324300	NFLONG-R1	B	4462	399	NA	NA	8/30/07	E	North Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
NFLC3.8			●	718022	4325797	Comparison Reach	B2-3	4859	431	NA	NA	9/5/07	E	North Fork Long Canyon Creek upstream of Diversion
<b>Duncan Creek</b>														
D6.3		●		715487	4332062	DUN-R2	B/F	4787	446	456	NA	9/6/07, 10/22/08	E	Duncan Creek from Diversion to confluence with Middle Fork American River
D8.3		●		717414	4334421	DUN-R2	B/F	5208	NA	439	NA	10/23/08	E	Duncan Creek from Diversion to confluence with Middle Fork American River
D9.0			●	718147	4335162	Comparison Reach	B1-2	5338	457	458	NA	9/7/07, 10/28/08	E	Duncan Creek upstream of Diversion
D10.0			●	719115	4336012	Comparison Reach	B3	5556	NA	446	NA	10/29/08	E	Duncan Creek upstream of Diversion
<b>North Fork of the Middle Fork American River</b>														
NFMF2.3			●	697266	4321655	Comparison Reach	F2-3/B2-3	1263	818	864	NA	10/1/07, 9/24/08	S, E	North Fork of the Middle Fork American River near Circle Bridge
<b>North Fork American River</b>														
NF18.4	●			669483	4306278	Lower NF American River	F	509	4394	NA	NA	10/9/07	S	North Fork American River below the confluence with the Middle Fork American River
NF31.3			●	677360	4317941	Comparison Reach	F3-4	781	3195	NA	NA	10/4/07	S	North Fork American River above Lake Clementine
NF53.7			●	691800	4338960	Comparison Reach	unknown	1824	1823	1823	NA	8/31/07, 9/25/08	S, E	Upper North Fork American River

<sup>1</sup>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

<sup>2</sup>Universal Transverse Mercator Zone 10 North, North American Datum 1983

<sup>3</sup>See Map AQ 2-1

<sup>4</sup>Rosgen Level I is only available for Comparison Reaches

<sup>5</sup>S = Snorkel, E = Electrofish

**Table AQ 2-2. 2007-2008 Reservoir and Diversion Pool Sampling Locations and Effort.**

Reservoir/Diversion Pool	Sampling Date	Sampling Method
<b>Middle Fork American River</b>		
French Meadows Reservoir	9/11/07	gill net
Middle Fork Interbay	9/20/07	gill net
Ralston Afterbay	9/13/07	gill net
Ralston Afterbay	6/26/08, 9/4/08	gill net/electrofish/sonar
<b>Rubicon River</b>		
Hell Hole Reservoir	9/10/07	gill net
<b>Long Canyon Creek</b>		
North Fork Long Canyon Creek Diversion Pool	9/4/07	snorkel
South Fork Long Canyon Creek Diversion Pool	9/4/07	snorkel
<b>Duncan Creek</b>		
Duncan Creek Diversion Pool	10/12/07, 10/26/07	snorkel

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

Study Sites	Description	Peaking Reach	Bypass Reach	Comparison Site	Validity of Study Site Comparison		Rationale	
					By Length	By Area		
MF44.7	Middle Fork American River below French Meadows Reservoir		●		Poor	Poor	Dissimilar channel type, slope, and pool depth. Similar wetted width.	
MF51.8	Middle Fork American River above French Meadows Reservoir			●				
R25.7	Rubicon River below Hell Hole Reservoir		●		Poor	Poor	Dissimilar channel type, slope, wetted width, and pool depth.	
R36.2	Rubicon River above Hell Hole Reservoir			●				
NFLC1.9	North Fork Long Canyon Creek below diversion		●		Moderate	Moderate	Similar channel type, wetted width, and pool depth. Dissimilar slope.	
NFLC3.8	North Fork Long Canyon Creek above diversion			●				
SFLC2.3	South Fork Long Canyon Creek below diversion		●		Good <sup>1</sup>	Good <sup>1</sup>	Generally Similar channel type, slope, wetted width, and pool depth. <sup>1</sup>	
SFLC3.0	South Fork Long Canyon Creek below diversion		●					
SFLC4.2	South Fork Long Canyon Creek above diversion			●				
SFLC5.2	South Fork Long Canyon Creek above diversion			●				
D6.3	Duncan Creek below diversion		●		Good	Good	Similar channel type, slope, pool depth, wetted width.	
D8.3			●					
D9.0		Duncan Creek above diversion			●	Poor	Poor	Similar pool depth and wetted width. Dissimilar channel type and slope.
D10.0				●				
MF4.8	Middle Fork American River above Mammoth Bar	●			Moderate	Moderate	Similar channel type and slope. Dissimilar wetted width and pool depth.	
NF31.3	North Fork American River at Ponderosa Bridge			●				
MF14.1	Middle Fork American River at Otter Creek	●			Good	Good	Similar channel type, slope, wetted width, and pool depth.	
NF31.3	North Fork American River at Ponderosa Bridge			●				
MF23.5	Middle Fork American River at Horseshoe Bar	●			Moderate	Moderate	Similar channel type, slope, and pool depth. Moderately dissimilar wetted width.	
NF31.3	North Fork American River at Ponderosa Bridge			●				
NF18.4	North Fork American River below Middle Fork American River Confluence	●			Good	Good	Similar channel type, slope, wetted width, and pool depth.	
NF31.3	North Fork American River at Ponderosa Bridge			●				
MF26.2	Middle Fork American River above Ralston Afterbay		●		Good	Good	Similar channel type, slope, wetted width, and pool depth.	
NFMF2.3	North Fork Middle Fork American River at Circle Bridge			●				
R3.5	Rubicon River at Long Canyon Creek		●		Good-Moderate	Good-Moderate	Similar channel type, wetted width, and pool depth. Moderately dissimilar slope.	
NF53.7	Upper North Fork American River			●				
R20.9	Rubicon River at Ellicott Bridge		●		Good-Moderate	Good-Moderate	Similar channel type, wetted width, and pool depth. Moderately dissimilar slope.	
NF53.7	Upper North Fork American River			●				

<sup>1</sup> The sites above the diversion are narrower and more confined.

Table AQ 2-4. Summary of Fish Species Observed during the 2007-2009 Fish Population Sampling (●).

Study Site	DATE	Sample Type <sup>1</sup>	Fish Species <sup>2</sup>														
			RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	KOK	TCB	LKT	WCF
<b>Middle Fork American River Downstream of Ralston Afterbay</b>																	
MF4.8	10/3/2007; 9/29/08	QUANT	●	●			●	●	●								
MFAR at RM4.8	10/3/2007; 8/6/08	QUAL				●		●	●								
MF14.1	10/2/2007; 10/16/07; 9/30/08	QUANT	●	●				●	●								
Otter Creek at MF14.1	10/2/07; 10/16/07; 8/6/08	QUAL	●		●	●	●	●	●			●					
Gas Canyon	5/7/07	QUAL	●	●					●								
MF23.5	10/8/07	QUANT	●	●			●										
MFAR at RM23.5	6/5/08	QUAL	●	●	●	●		●	●								
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>																	
MF26.2	9/18/2007; 9/15/08	QUANT	●	●	●	●	●	●	●	●	●	●					
MFAR at RM26.2	6/5/07; 6/25/07; 7/16/07; 7/16/08	QUAL	●	●	●	●	●	●	●	●	●	●					
MFAR at RM26.6	7/16/08	QUAL	●	●													
MFAR at RM29.4	10/24/07	QUAL	●	●													
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>																	
MF36.2	9/21/07	QUANT	●	●													
MF44.7	9/26/07; 10/27/08	QUANT	●	●													
MF51.8	10/11/07	QUANT	●	●													
<b>Rubicon River</b>																	
Rubicon River RM0.0 - 0.5	5/11/07; 6/7/07; 6/27/07; 7/17/07	QUAL	●		●	●	●	●	●	●	●	●					
Rubicon at RM3.5	6/12/07; 7/15/08	QUAL	●	●	●	●	●					●					
R3.5	9/17/07	QUANT	●	●		●	●	●	●	●	●	●					
Rubicon River at RM5.2	10/24/07; 7/21/08	QUAL	●	●	●	●	●					●					
Rubicon River at RM6.2	7/21/08	QUAL	●	●	●	●						●					
Rubicon River at RM8.0	8/8/08	QUAL	●	●		●						●					
Rubicon River at RM9.9	9/27/07; 8/8/08	QUAL	●	●								●					
Rubicon River at RM14.3	9/27/07	QUAL	●	●								●					
R20.9	9/19/07; 9/26/08	QUANT	●	●					●								
R25.7	9/25/07	QUANT	●	●													
R36.2	9/27/07	QUANT	●	●								●					
<b>Long Canyon Creek</b>																	
LC at RM0.2	7/15/08	QUAL	●	●	●	●						●					
LC9.0	10/8/07	QUANT	●														
<b>North Fork Long Canyon Creek</b>																	
NFLC1.9	8/30/07	QUANT	●														
NFLC3.8	9/5/07	QUANT	●														
NFLC RM3.6 - 5.0	5/17/07; 6/16/07; 6/26/07	QUAL	●														

Table AQ 2-4. Summary of Fish Species Observed during the 2007-2009 Fish Population Sampling (●) (continued).

Study Site	DATE	Sample Type <sup>1</sup>	Fish Species <sup>2</sup>														
			RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	KOK	TCB	LKT	WCF
<b>South Fork Long Canyon Creek</b>																	
SFLC2.3	8/28/07; 9/9/08; 10/5/09	QUANT	●														
SFLC3.0	10/6/09	QUANT	●														
SFLC4.2	8/29/07; 9/10/08; 10/7/09	QUANT	●														
SFLC5.2	10/9/09	QUANT	●														
SFLC RM5.7 - 9.4	5/17/07; 6/16/07; 6/26/07	QUAL	●														
<b>Duncan Creek</b>																	
D6.3	9/6/07, 10/22/08	QUANT	●	●													
D8.3	10/23/08	QUANT	●	●													
D9.0	9/7/07, 10/28/08	QUANT	●	●													
D10.0	10/29/08	QUANT	●	●													
Duncan Creek RM9.0 - 13.6	5/17/07; 6/16/07; 6/26/07	QUAL	●	●													
<b>North Fork of the Middle Fork American River</b>																	
NFMF at RM0.2	7/17/08	QUAL	●	●	●	●					●						
NFMF2.3	10/1/07; 9/24/08	QUANT	●			●		●	●	●	●						
<b>North Fork American River</b>																	
NF18.4	10/9/07	QUANT	●	●				●	●								
NF31.3	10/21/07	QUANT	●			●	●	●	●			●	●				
NF at RM31.3	10/21/07; 8/14/08	QUAL	●		●	●		●	●			●	●				●
NF at RM36.0	8/15/08	QUAL	●		●	●						●					
NF53.7	8/31/07; 9/25/08	QUANT	●			●	●	●	●	●	●						
<b>Diversion Pools</b>																	
NFLC	9/4/07	QUANT	dry														
SFLC	9/4/07	QUANT	●														
Duncan	10/2/2007; 10/26/2007	QUANT	●	●													
<b>Reservoirs</b>																	
Ralston Afterbay	9/13/07; 6/26/08; 9/4/08	Gill netting/ electrofishing	●	●	●	●		●									
Middle Fork Interbay	9/20/07-9/21/07	Gill netting	●	●													
French Meadows	9/11/07-9/13/07	Gill netting	●	●										● <sup>3</sup>	●		
Hell Hole	9/10/07-9/12/07	Gill netting	●	●				●						●	●	●	

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

<sup>2</sup>Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pikeminnow; 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

<sup>3</sup>Anomalous Kokanee observation at French Meadows Reservoir

Table AQ 2-5. Reservoir Gill Netting Catch and Catch Per Unit Effort (CPUE) for 2007, 2008, and for Historical Sampling Data.

Date	Total Nets Deployed	Total Deployment Hours	Average Hours per Net	Reservoir Totals		RBT <sup>1</sup>		RBT X CT		BNT		HH		SPM		SS		KOK		TCB		LKT	
				Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour	Total Fish	fish per net hour
<b>French Meadows Reservoir</b>																							
9/11/2007 <sup>3</sup>	12	243.0	20.3	37	0.152	8	0.033			28	0.115							1	0.004	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												
<b>Middle Fork Interbay</b>																							
9/20/2007	4	80.0	20.0	12	0.150	5	0.063			7	0.088												
<b>Ralston Afterbay</b>																							
9/4/2008	6	117.2	19.5	65	0.555	6	0.051			4	0.034			2	0.017	53	0.452						
6/26/2008	6	122.6	20.4	105	0.856	8	0.065			8	0.065	3	0.024	2	0.016	84	0.685						
9/13/2007	6	110.7	18.4	92	0.831	6	0.054			10	0.090	6	0.054	4	0.036	66	0.596						
<b>Hell Hole Reservoir</b>																							
9/10/2007	10	194.5	19.4	141	0.725	0 <sup>2</sup>				23	0.118					98	0.504	12	0.062	6	0.031	2	0.010
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						

<sup>1</sup>Species: RBT = Rainbow Trout; CT = Cutthroat Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pikeminnow; SS = Sacramento Sucker; KOK = Kokanee; TCB = Tui Chub; LKT = Lake Trout

<sup>2</sup>One RBT captured during qualitative methylmercury tissue sampling

<sup>3</sup>Anomalous Kokanee observation at French Meadows Reservoir

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

Study Site	Year	Species <sup>1</sup> Density (fish per mile)										
		RBT (% YOY) <sup>c</sup>	BNT (% YOY)	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN
<b>Middle Fork American River Downstream of Ralston Afterbay</b>												
MF4.8	2007	142 (0%)	19 (0%)	--	--	1308	831	6.8	--	--	--	--
	2008	33 (0%)	14 (0%)	--	--	--	31	--	--	--	--	--
MF14.1	2007	307 (2%)	69 (0%)	--	--	--	3.1	7.8	--	--	--	--
	2008	81 (0%)	13 (0%)	--	--	--	2	--	--	--	--	--
MF23.5	2008	372 (0%)	37 (0%)	--	--	--	--	--	--	--	--	--
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>												
MF26.2	2007	440 (14%)	16 (0%)	5.4	120	289	228	696	56	272	--	--
	2008	361 (19%)	11 (50%)	--	172	210	48	770	27	145	--	--
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>												
MF36.2	2007	2511 (74%)	287 (85%)	--	--	--	--	--	--	--	--	--
MF44.7	2007	550 (44%)	714 (23%)	--	--	--	--	--	--	--	--	--
	2008	563 (27%)	361 (19%)	--	--	--	--	--	--	--	--	--
MF51.8	2007	2512 (92%)	2056 (99%)	--	--	--	--	--	--	--	--	--
<b>Rubicon River</b>												
R3.5	2007	200 (43%)	4 (0%)	--	41	5347	3.7	870	777	63	--	--
R20.9	2007	1402 (41%)	43 (30%)	--	--	--	--	--	--	--	--	--
	2008	690 (28%)	17 (0%)	--	--	--	--	--	--	--	--	--
R25.7	2007	1688 (60%)	256 (68%)	--	--	--	--	--	--	--	--	--
R36.2	2007	1435 (78%)	100 (92%)	--	--	--	--	--	--	--	--	--
<b>Long Canyon Creek</b>												
LC9.0	2007	6680 (88%)	--	--	--	--	--	--	--	--	--	--
<b>North Fork Long Canyon Creek</b>												
NFLC1.9	2007	4777 (61%)	--	--	--	--	--	--	--	--	--	--
NFLC3.8	2007	3504 (55%)	--	--	--	--	--	--	--	--	--	--
<b>South Fork Long Canyon Creek</b>												
SFLC2.3	2007	4386 (74%)	--	--	--	--	--	--	--	--	--	--
	2008	5035 (73%)	--	--	--	--	--	--	--	--	--	--
	2009	2189 (46%)	--	--	--	--	--	--	--	--	--	--
SFLC3.0	2009	2509 (52%)	--	--	--	--	--	--	--	--	--	--
SFLC4.2	2007	4757 (71%)	--	--	--	--	--	--	--	--	--	--
	2008	4958 (64%)	--	--	--	--	--	--	--	--	--	--
	2009	2573 (52%)	--	--	--	--	--	--	--	--	--	--
SFLC5.2	2009	1796 (46%)	--	--	--	--	--	--	--	--	--	--
<b>Duncan Creek</b>												
D6.3	2007	2747 (63%)	651 (75%)	--	--	--	--	--	--	--	--	--
	2008	2617 (35%)	556 (17%)	--	--	--	--	--	--	--	--	--
D8.3	2008	3095 (37%)	373 (42%)	--	--	--	--	--	--	--	--	--
D9.0	2007	2438 (60%)	139 (67%)	--	--	--	--	--	--	--	--	--
	2008	2859 (47%)	92 (0%)	--	--	--	--	--	--	--	--	--
D10.0	2008	1942 (29%)	130 (9%)	--	--	--	--	--	--	--	--	--

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

Study Site	Year	Species <sup>1</sup> Density (fish per mile)										
		RBT (% YOY) <sup>2</sup>	BNT (% YOY)	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN
<b>North Fork of the Middle Fork American River</b>												
NFMF2.3	2007	710 (47%)	--	--	13	--	200	297	787	1704	--	--
	2008	452 (26%)	--	--	43	3599	251	196	293	1986	--	--
<b>North Fork American River</b>												
NF18.4	2007	62 (0%)	1 (0%)	--	--	--	23	7.2	--	--	--	--
NF31.3	2007	5 (0%)	--	--	32	128	10	5.0	--	--	6.6	3.3
NF53.7	2007	403 (8%)	--	--	17	3224	226	14	75	104	--	--
	2008	298 (0%)	--	--	24	30	57	6	98	131	--	--

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

<sup>2</sup>YOY: young-of-the-year. For electrofishing, YOY were assumed to be <100 mm during the fall (based on length frequency analysis). YOY during snorkle surveys were assumed to be <3" (76 mm). The 3" size class was based on CDFG convention.

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

Study Site	Year	Species <sup>1</sup> Density (fish per acre)										
		RBT (% YOY) <sup>2</sup>	BNT (% YOY)	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN
<b>Middle Fork American River Downstream of Ralston Afterbay</b>												
MF4.8	2007	10 (0%)	1 (0%)	--	--	73	61	0.5	--	--	--	--
	2008	2 (0%)	1 (0%)	--	--	--	2	--	--	--	--	--
MF14.1	2007	24 (2%)	5 (0%)	--	--	--	0.2	0.6	--	--	--	--
	2008	6 (0%)	1 (0%)	--	--	--	--	--	--	--	--	--
MF23.5	2008	33 (0%)	3 (0%)	--	--	--	--	--	--	--	--	--
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>												
MF26.2	2007	78 (14%)	3 (0%)	1.0	21	50	40	123	10	48	--	--
	2008	65 (19%)	2 (50%)	--	31	38	9	138	5	26	--	--
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>												
MF36.2	2007	643 (74%)	73 (85%)	--	--	--	--	--	--	--	--	--
MF44.7	2007	124 (44%)	161 (23%)	--	--	--	--	--	--	--	--	--
	2008	177 (27%)	113 (19%)	--	--	--	--	--	--	--	--	--
MF51.8	2007	479 (92%)	392 (99%)	--	--	--	--	--	--	--	--	--
<b>Rubicon River</b>												
R3.5	2007	27 (43%)	1 (0%)	--	5.5	727	0.5	118	106	8.5	--	--
R20.9	2007	193 (41%)	6 (30%)	--	--	--	--	--	--	--	--	--
	2008	95 (28%)	2 (0%)	--	--	--	--	1	--	--	--	--
R25.7	2007	167 (60%)	25 (68%)	--	--	--	--	--	--	--	--	--
R36.2	2007	425 (78%)	30 (92%)	--	--	--	--	--	--	--	--	--
<b>Long Canyon Creek</b>												
LC9.0	2007	3392 (88%)	--	--	--	--	--	--	--	--	--	--
<b>North Fork Long Canyon Creek</b>												
NFLC1.9	2007	2990 (61%)	--	--	--	--	--	--	--	--	--	--
NFLC3.8	2007	2476 (55%)	--	--	--	--	--	--	--	--	--	--
<b>South Fork Long Canyon Creek</b>												
SFLC2.3	2007	2935 (74%)	--	--	--	--	--	--	--	--	--	--
	2008	3166 (73%)	--	--	--	--	--	--	--	--	--	--
	2009	1361 (46%)	--	--	--	--	--	--	--	--	--	--
SFLC3.0	2009	1475 (52%)	--	--	--	--	--	--	--	--	--	--
SFLC4.2	2007	3703 (71%)	--	--	--	--	--	--	--	--	--	--
	2008	3965 (64%)	--	--	--	--	--	--	--	--	--	--
	2009	1744 (52%)	--	--	--	--	--	--	--	--	--	--
SFLC5.2	2009	1480 (46%)	--	--	--	--	--	--	--	--	--	--
<b>Duncan Creek</b>												
D6.3	2007	1128 (63%)	267 (75%)	--	--	--	--	--	--	--	--	--
	2008	1033 (35%)	219 (17%)	--	--	--	--	--	--	--	--	--
D8.3	2008	1524 (37%)	184 (42%)	--	--	--	--	--	--	--	--	--
D9.0	2007	947 (60%)	54 (67%)	--	--	--	--	--	--	--	--	--
	2008	1231 (47%)	40 (0%)	--	--	--	--	--	--	--	--	--
D10.0	2008	882 (29%)	59 (9%)	--	--	--	--	--	--	--	--	--

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

Study Site	Year	Species <sup>1</sup> Density (fish per acre)										
		RBT (% YOY) <sup>2</sup>	BNT (% YOY)	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN
<b>North Fork of the Middle Fork American River</b>												
NFMF2.3	2007	141 (47%)	--	--	3	--	40	59	156	339	--	--
	2008	88 (26%)	--	--	8	700	49	38	57	386	--	--
<b>North Fork American River</b>												
NF18.4	2007	5 (0%)	--	--	--	--	1.7	0.5	--	--	--	--
NF31.3	2007	0 (0%)	--	--	2.8	11	0.9	0.4	--	--	0.6	0.3
NF53.7	2007	50 (8%)	--	--	2.2	404	28	1.8	9.4	13	--	--
	2008	36 (7%)	--	--	3	4	7	1	12	16	--	--

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

<sup>2</sup>YOY: young-of-the-year. For electrofishing, YOY were assumed to be <100 mm during the fall (based on length frequency analysis). YOY during snorkle surveys were assumed to be <3" (76 mm). The 3" size class was based on CDFG convention.

**Table AQ 2-8. Fish Counts and Total Fish Estimates from Ralston Afterbay Sonar Sampling.**

<b>Early Summer - June 26, 2008</b>					
<b>Depth (ft)</b>	<b>Fish Count</b>	<b>Reservoir Volume Surveyed (10 ft<sup>3</sup>)</b>	<b>Total Reservoir Volume (10 ft<sup>3</sup>)</b>	<b>Percent of Reservoir Volume Surveyed</b>	<b>Total Fish Estimate</b>
0.0 - 3.4	97	113	9,499	1.2%	8,154
3.4 - 8.4	57	378	12,662	3.0%	1,909
8.4 - 13.4	34	365	9,181	4.0%	855
13.4 - 18.4	9	187	5,463	3.4%	263
18.4 - 23.4	0	41	3,058	1.3%	0
23.4 - 28.4	0	0.01	1,359	<0.01%	0
28.4 - 33.4	0	0	634	0	--
33.4 - 38.4	0	0	352	0	--
38.4 - 43.4	0	0	204	0	--
43.4 - 48.4	0	0	91	0	--
<b>Total</b>	<b>197</b>	<b>1,084.01</b>	<b>41,222</b>	<b>2.6%</b>	<b>11,181</b>
<b>Fall - Sept. 3, 2008</b>					
<b>Depth (ft)</b>	<b>Fish Count</b>	<b>Reservoir Volume Surveyed (10 ft<sup>3</sup>)</b>	<b>Total Reservoir Volume (10 ft<sup>3</sup>)</b>	<b>Percent of Reservoir Volume Surveyed</b>	<b>Total Fish Estimate</b>
0.0 - 4.1	194	211	11,633	1.8%	10,696
4.1 - 9.1	57	748	12,662	5.9%	965
9.1 - 14.1	27	863	9,181	9.4%	287
14.1 - 19.1	8	781	5,463	14.3%	56
19.1 - 24.1	10	535	3,058	17.5%	57
24.1 - 29.1	5	217	1,359	16.0%	31
29.1 - 34.1	5	125	634	19.7%	25
34.1 - 39.1	3	93	352	26.4%	11
39.1 - 44.1	0	63	204	30.9%	0
44.1 - 49.1	0	29	91	31.9%	0
<b>Total</b>	<b>309</b>	<b>3,665</b>	<b>44,637</b>	<b>8.2%</b>	<b>12,128</b>

**Table AQ 2-9. Density of Species, Fish per Mile of Shoreline, Captured during Ralston Afterbay Electrofishing Efforts (Total Ralston Afterbay Shoreline = 2.98 miles).**

Species <sup>1</sup>	Size Class <sup>2</sup>	Fish per Mile (Number of Fish Captured)	
		Jun 26, 2008 0.34 miles sampled	Sep 4, 2008 0.68 miles sampled
RBT	YOY	2.9 (1)	--
	3-6"	--	--
	6-12"	2.9 (1)	2.9 (2)
	12-18"	--	--
	18"+	--	--
BNT	YOY	--	--
	3-6"	2.9 (1)	1.5 (1)
	6-12"	2.9 (1)	--
	12-18"	2.9 (1)	1.5 (1)
	18"+	2.9 (1)	1.5 (1)
HH	YOY	5.9 (2)	1.5 (1)
	3-6"	108.8 (37)	104.4 (71)
	6-12"	--	1.5 (1)
	12-18"	--	--
	18"+	--	--
SPM	YOY	8.8 (3)	--
	3-6"	108.8 (37)	102.9 (71)
	6-12"	2.9 (1)	2.9 (1)
	12-18"	--	--
	18"+	--	1.5 (1)
SS	YOY	5.9 (2)	--
	3-6"	123.5 (42)	44.1 (30)
	6-12"	5.9 (2)	8.8 (6)
	12-18"	--	4.4 (3)
	18"+	--	10.3 (7)

<sup>1</sup>Species: RBT = Rainbow Trout, BNT = Brown Trout, HH = Hardhead, SPM = Sacramento Pikeminnow, SS = Sacramento Sucker

<sup>2</sup>YOY = Young-of-the-year

**Table AQ 2-10. Results from Diversion Pool Fish Population Survey.<sup>1</sup>**

Date	RBT <sup>2</sup>				BNT				Unknown Trout	Notes
	YOY	3-6"	6-12"	12+"	YOY	3-6"	6-12"	12+"		
<b>Duncan Creek Diversion Pool</b>										
10/12/2007	--	--	--	--	--	--	--	--	--	Poor visibility. Not sampled.
10/26/2007	0	1	0	1	0	0	0	1	1 (12+)"	Good visibility. Maximum depth 12-15'.
<b>North Fork Long Canyon Diversion Pool</b>										
9/4/2007	--	--	--	--	--	--	--	--	--	No fish observed.
<b>South Fork Long Canyon Diversion Pool</b>										
9/4/2007	1	10	1	0	0	0	0	0	0	--

<sup>1</sup>All diversion pools were surveyed by snorkeling

<sup>2</sup>Species: RBT = Rainbow Trout; BNT = Brown Trout; YOY=Young-of-the-Year

**Table AQ 2-11. Rainbow Trout (RBT) and Brown Trout (BNT) Biomass at Quantitative River Study Sites.**

Study Site	Year	Pounds per Mile			Pounds per Acre		
		Total	RBT	BNT	Total	RBT	BNT
<b>Middle Fork American River Downstream of Ralston Afterbay</b>							
MF4.8	2007	116	87	29	9	6.4	2.1
	2008	41	30	12	3	2.2	0.8
MF14.1	2007	349	243	106	27	19	8.1
	2008	55	45	10	4	3.4	0.8
MF23.5	2008	261	223	39	23	20	3.4
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>							
MF26.2	2007	81	65	16.0	14	12	2.8
	2008	52	52	0.5	9	9.3	0.1
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>							
MF36.2	2007	164	142	22	42	36	5.6
MF44.7	2007	78	22	56	18	4.9	13
	2008	87	52	35	27	16	11
MF51.8	2007	37	20	17.0	7.0	3.7	3.2
<b>Rubicon River</b>							
R3.5	2007	53	47	6.3	7	6	0.9
R20.9	2007	156	140	15	21	19	2.1
	2008	65	55	10	9	7	1.4
R25.7	2007	230	217	13	23	21	1.3
R36.2	2007	46	45	1.0	14	13	0.3
<b>Long Canyon Creek</b>							
LC9.0	2007	136	136	0.0	69	69	0.0
<b>North Fork Long Canyon Creek</b>							
NFLC1.9	2007	113	113	0.0	71	71	0.0
NFLC3.8	2007	87	87	0.0	62	62	0.0
<b>South Fork Long Canyon Creek</b>							
SFLC2.3	2007	89	89	0.0	60	60	0.0
	2008	98	98	0.0	62	62	0.0
	2009	78	78	0.0	49	49	0.0
SFLC3.0	2009	77	77	0.0	45	45	0.0
SFLC4.2	2007	79	79	0.0	61	61	0.0
	2008	127	127	0.0	102	102	0.0
	2009	92	92	0.0	63	63	0.0
SFLC5.2	2009	72	72	0.0	59	59	0.0
<b>Duncan Creek</b>							
D6.3	2007	103	70	33	42	29	14
	2008	135	94	41	53	37	16
D8.3	2008	139	121	19	69	59	9.3
D9.0	2007	93	86	7.1	36	33	2.8
	2008	112	100	12	48	43	5.1
D10.0	2008	131	118	13	60	54	6.1
<b>North Fork of the Middle Fork American River</b>							
NFMF2.3	2007	63	63	0.0	12	12	0.0
	2008	78	78	0.0	13	13	0.0
<b>North Fork American River</b>							
NF18.4	2007	43	41	2.0	3.2	3.1	0.2
NF31.3	2007	1.5	1.5	0.0	0.1	0.1	0.0
NF53.7	2007	97	97	0.0	12	12	0.0
	2008	97	97	0.0	12	12	0.0

<sup>1</sup>Species: RBT = Rainbow Trout, BNT = Brown Trout

<sup>2</sup>Weights were estimated for fish observed by snorkeling from length/weight regressions

Table AQ 2-12. Rainbow Trout (RBT) and Brown Trout (BNT) Condition Factors.

Study Site	Year	RBT		BNT	
		Condition Factor	n	Condition Factor	n
<b>Middle Fork American River Downstream of Ralston Afterbay</b>					
MF4.8	2007	--	NA <sup>1</sup>	--	NA <sup>1</sup>
	2008	--	NA <sup>1</sup>	--	NA <sup>1</sup>
MF14.1	2007	1.01	10	--	NA <sup>1</sup>
	2008	1.01	2	--	NA <sup>1</sup>
MF23.5	2008	--	NA <sup>1</sup>	--	NA <sup>1</sup>
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>					
MF26.2	2007	1.02	24	1.31	2
	2008	1.11	21	1.05	1
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>					
MF36.2	2007	1.04	43	1.05	1
MF44.7	2007	1.06	5	1.07	25
	2008	1.09	13	1.09	13
MF51.8	2007	1.07	15	1.05	3
<b>Rubicon River</b>					
R3.5	2007	1.06	11	--	Not Observed
R20.9	2007	1.05	98	1.14	4
	2008	1.10	84	1.15	3
R25.7	2007	1.09	27	1.13	6
R36.2	2007	1.08	38	0.98	1
<b>Long Canyon Creek</b>					
LC9.0	2007	1.10	81	--	Not Observed
<b>North Fork Long Canyon Creek</b>					
NFLC1.9	2007	1.05	79	--	Not Observed
NFLC3.8	2007	1.04	113	--	Not Observed
<b>South Fork Long Canyon Creek</b>					
SFLC2.3	2007	1.09	46	--	Not Observed
	2008	1.06	136	--	Not Observed
	2009	1.18	122	--	Not Observed
SFLC3.0	2009	1.13	96	--	Not Observed
SFLC4.2	2007	1.11	25	--	Not Observed
	2008	1.07	159	--	Not Observed
	2009	1.14	112	--	Not Observed
SFLC5.2	2009	1.12	80	--	Not Observed
<b>Duncan Creek</b>					
D6.3	2007	1.11	83	1.07	13
	2008	1.10	143	1.09	40
D8.3	2008	1.06	159	1.11	18
D9.0	2007	1.16	82	1.06	3
	2008	1.13	131	1.13	8
D10.0	2008	1.15	115	1.09	10
<b>North Fork of the Middle Fork American River</b>					
NFMF2.3	2007	1.09	22	--	Not Observed
	2008	1.06	32	--	Not Observed
<b>North Fork American River</b>					
NF18.4	2007	--	NA <sup>1</sup>	--	NA <sup>1</sup>
NF31.3	2007	--	NA <sup>1</sup>	--	NA <sup>1</sup>
NF53.7	2007	1.10	16	--	Not Observed
	2008	1.02	11	--	Not Observed

<sup>1</sup>NA=snorkel only site, no weights were collected to calculate biomass

**Table AQ 2-13. Snorkeling Versus Electrofishing Comparison in Run Mesohabitat Units.**

Study Site	Electrofishing 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
<b>Middle Fork American River</b>								
MF26.2	0	0	7	1	0 (100%)	0 (100%)	3 (43%)	0 (0%)
<b>Rubicon River</b>								
R3.5	0	0	0	0	0 (100%)	0 (100%)	0 (100%)	0 (100%)
<b>North Fork American River</b>								
NF53.7	0	0	13	0	0 (100%)	0 (100%)	13 (100%)	0 (100%)

**Table AQ 2-14. Species and Life Stage Periodicities.**

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

**FIGURES**

**Figure AQ 2-1. Fish Population Objectives, Related Study Elements, and Reports.**

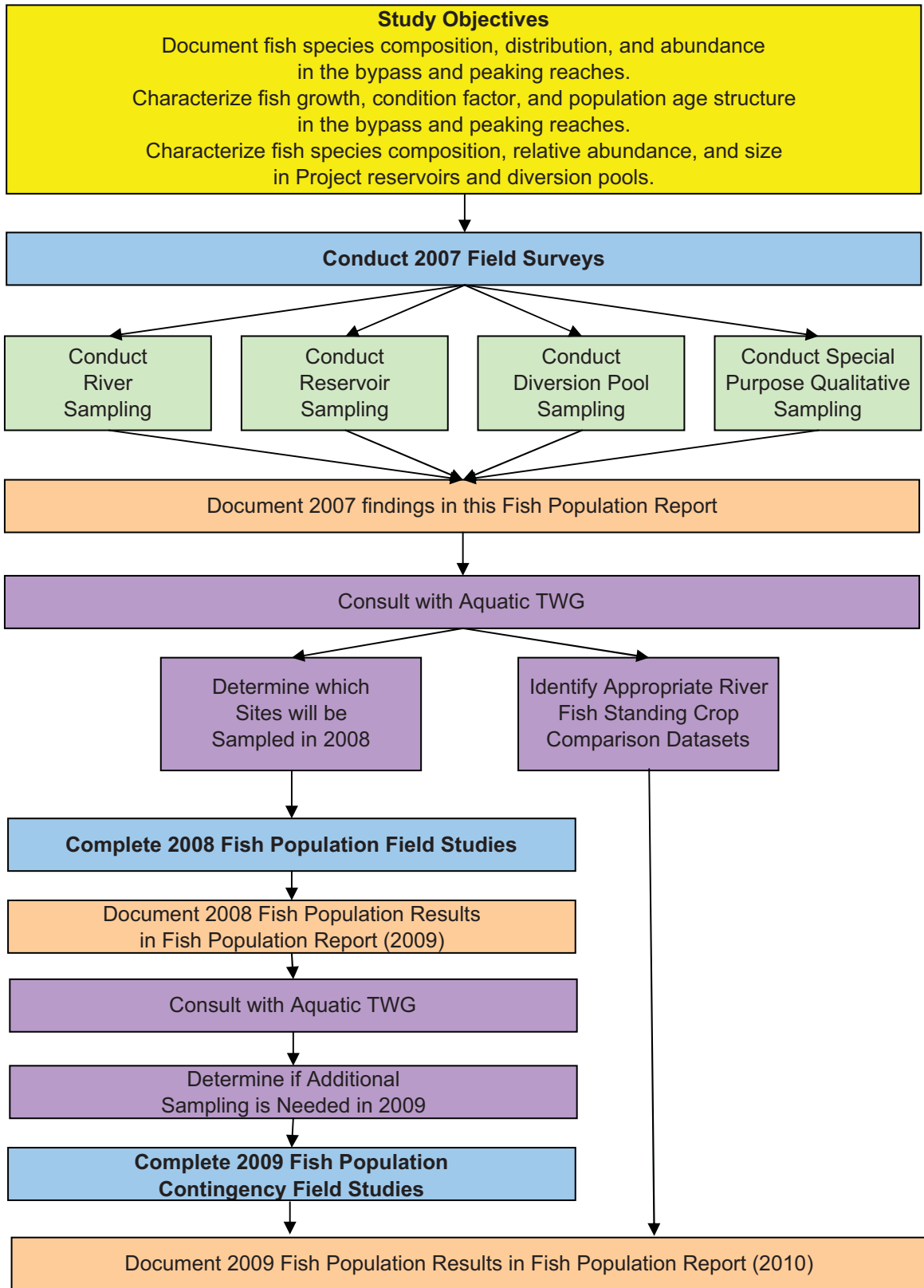
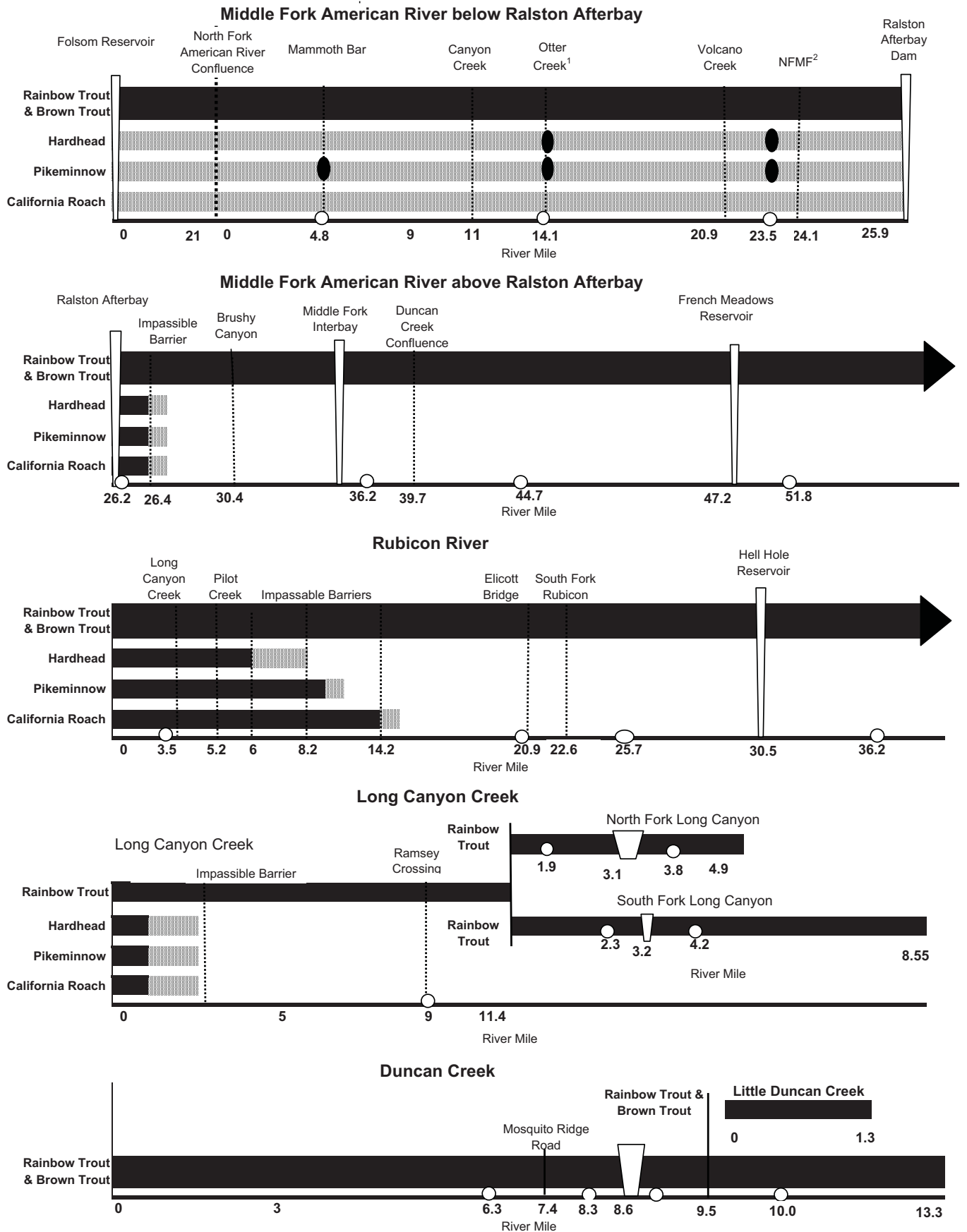
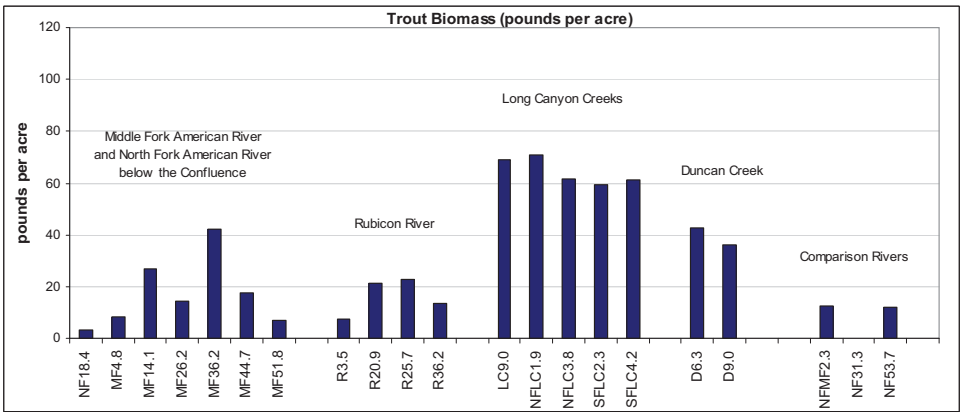
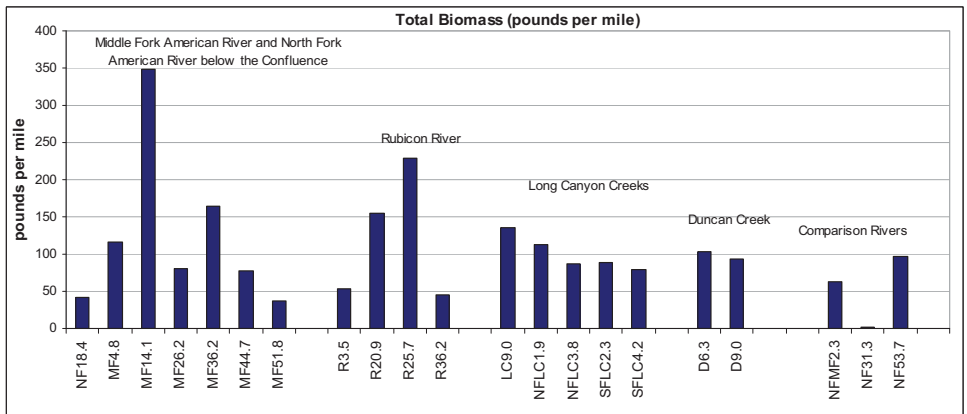
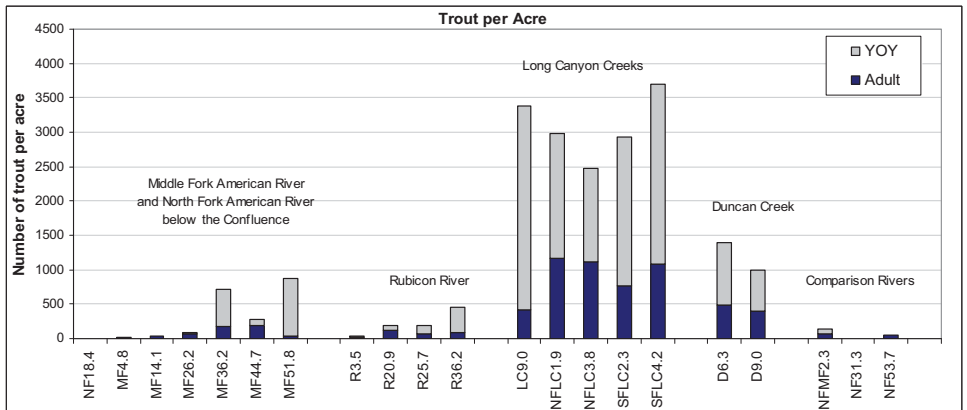
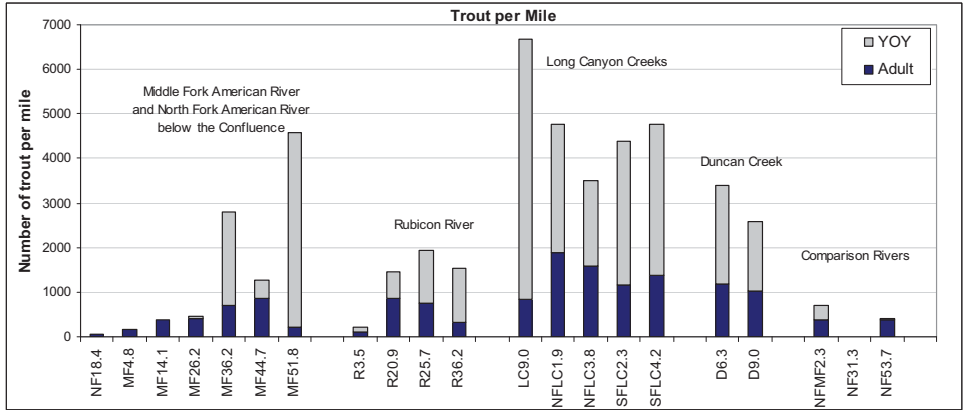


Figure AQ 2-2. Fish Distribution in the Middle Fork American River, Rubicon River, Long Canyon Creek, North Fork Long Canyon Creek, South Fork Long Canyon Creek, Duncan Creek, and Little Duncan Creek.



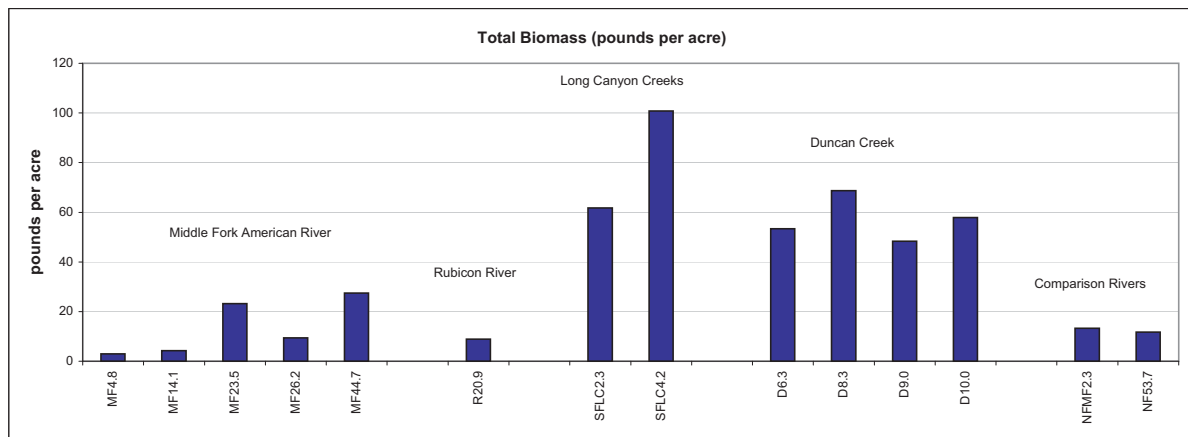
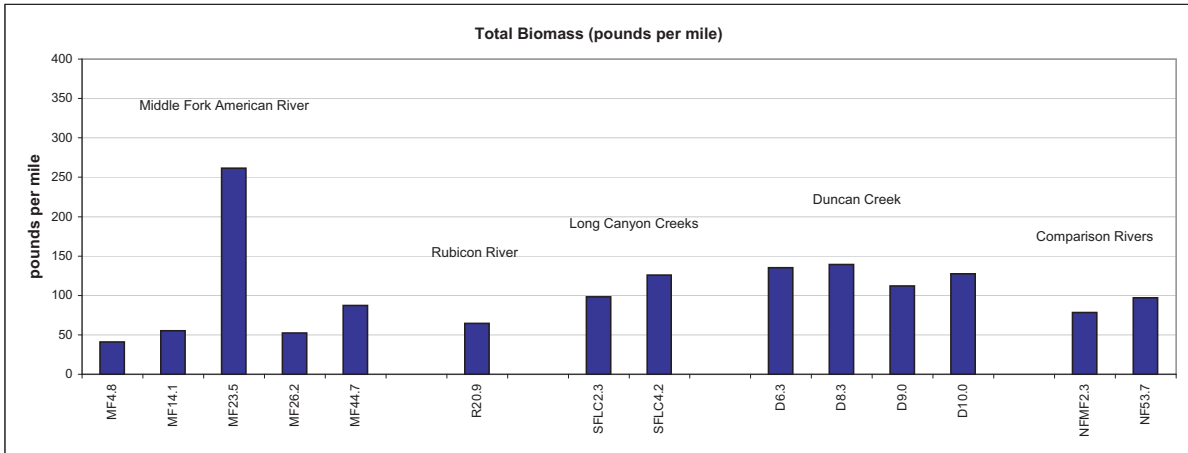
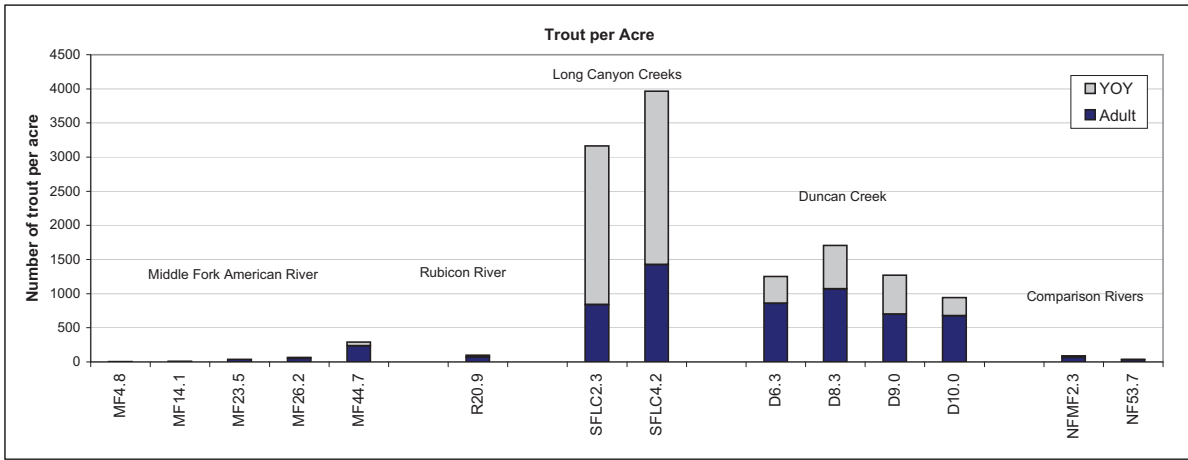
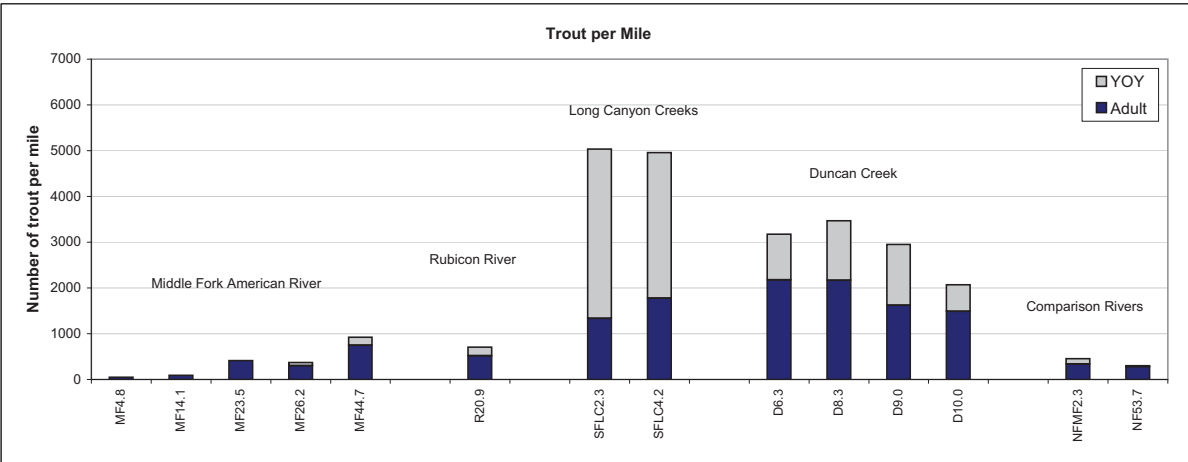
=Present   
  =Uncertain   
  =Diversion Dam   
  =Survey Site   
 <sup>1</sup>Hardhead were found in Otter Creek at the mouth   
 <sup>2</sup>NFMF= North Fork of the Middle Fork American River

Figure AQ 2-3a. The 2007 Density and Biomass of Trout in the Study Streams.



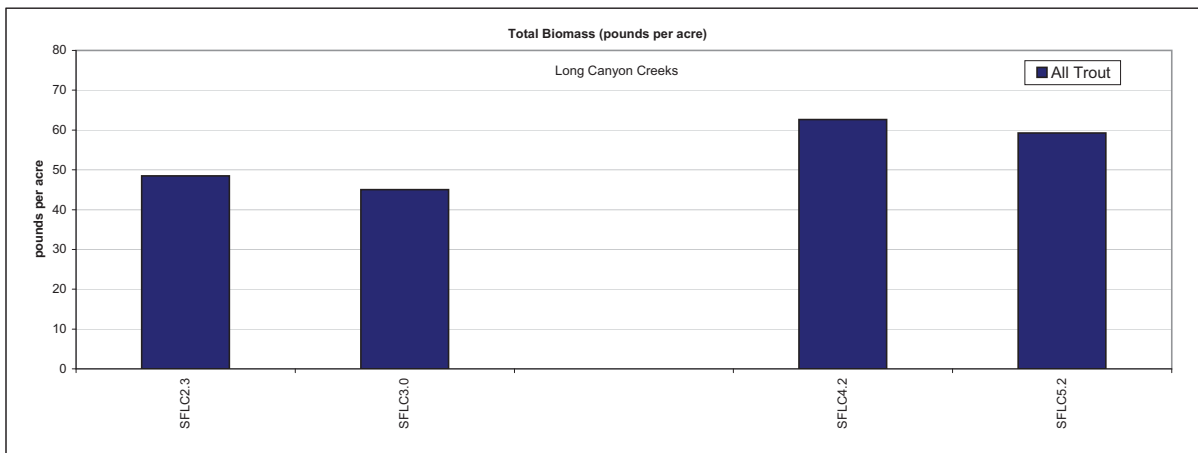
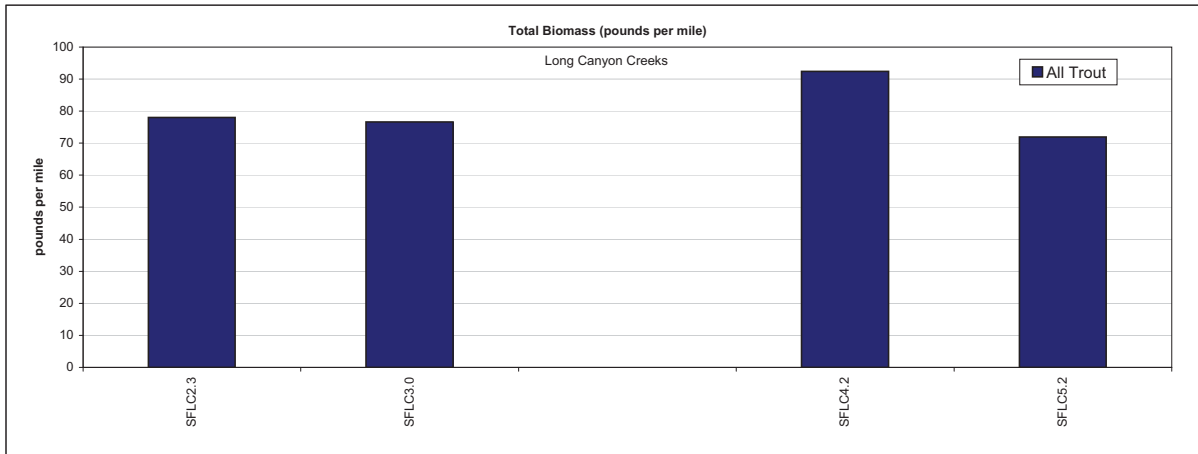
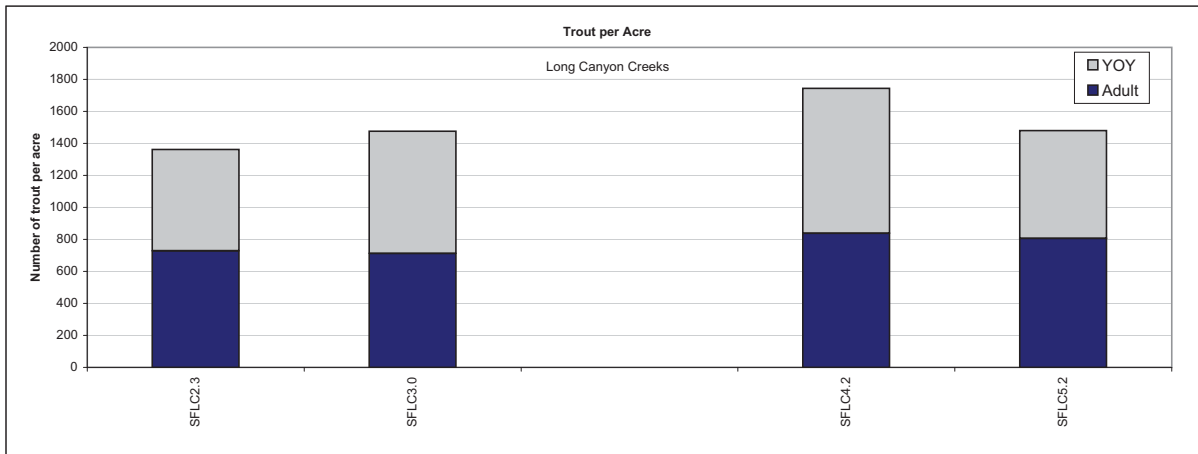
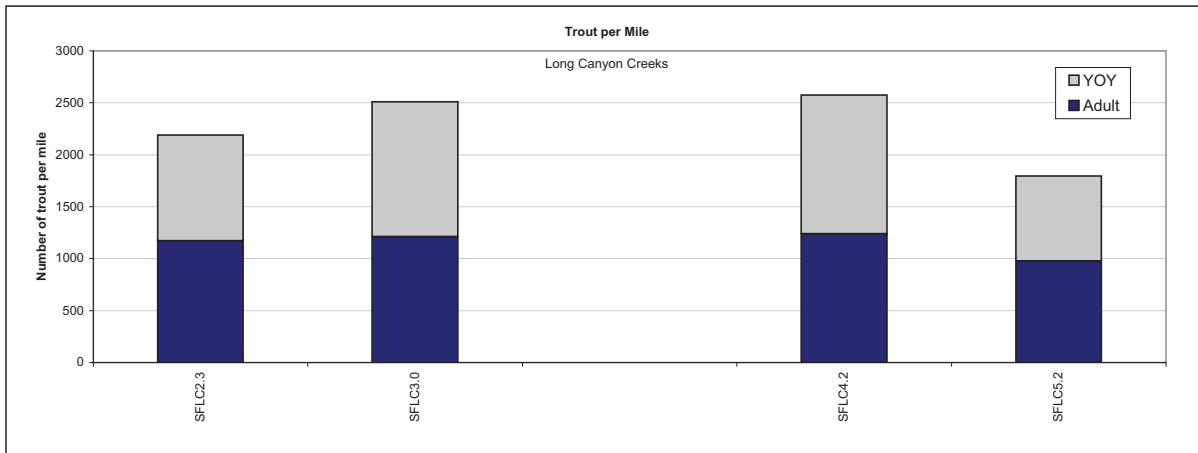
YOY: young-of-the-year

Figure AQ 2-3b. The 2008 Density and Biomass of Trout in the Study Streams.



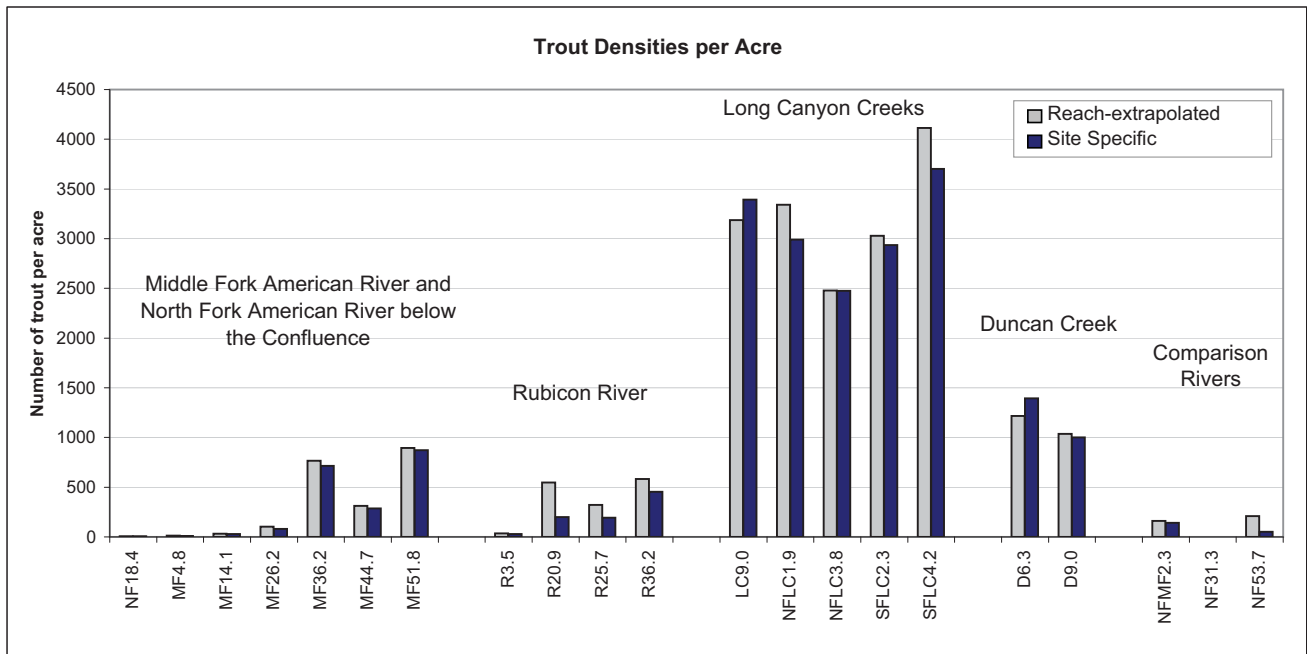
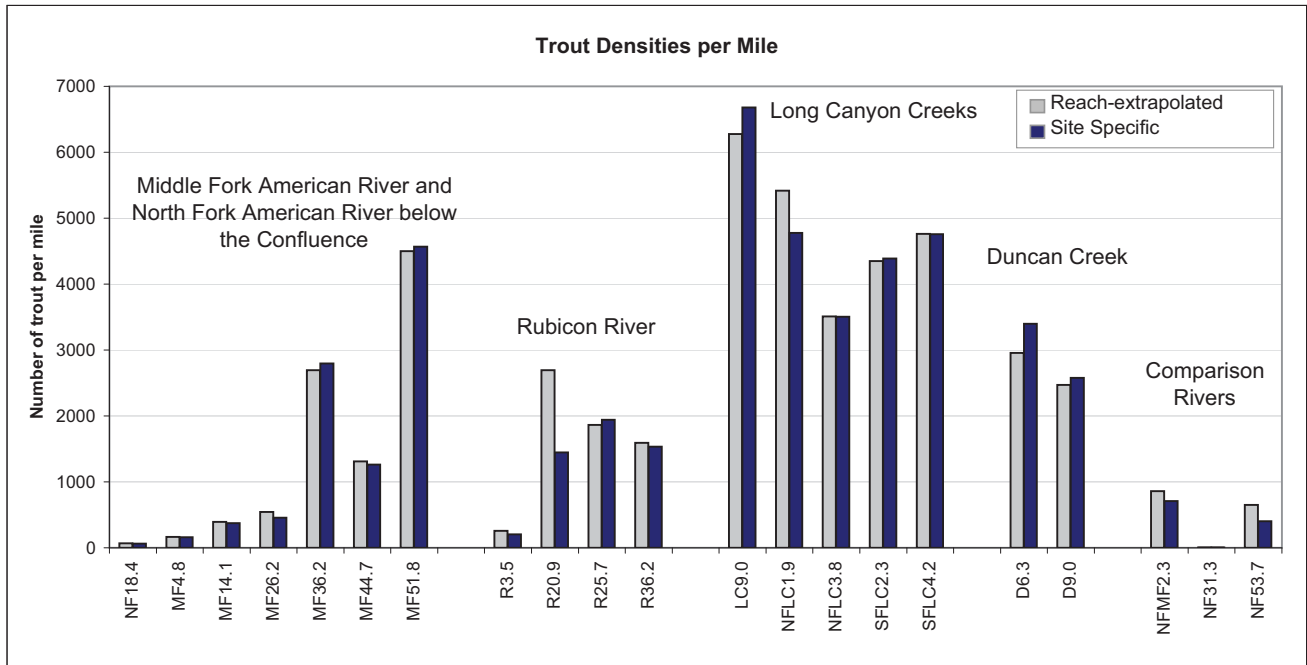
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Figure AQ 2-3c. The 2009 Density and Biomass of Trout in the Study Streams.



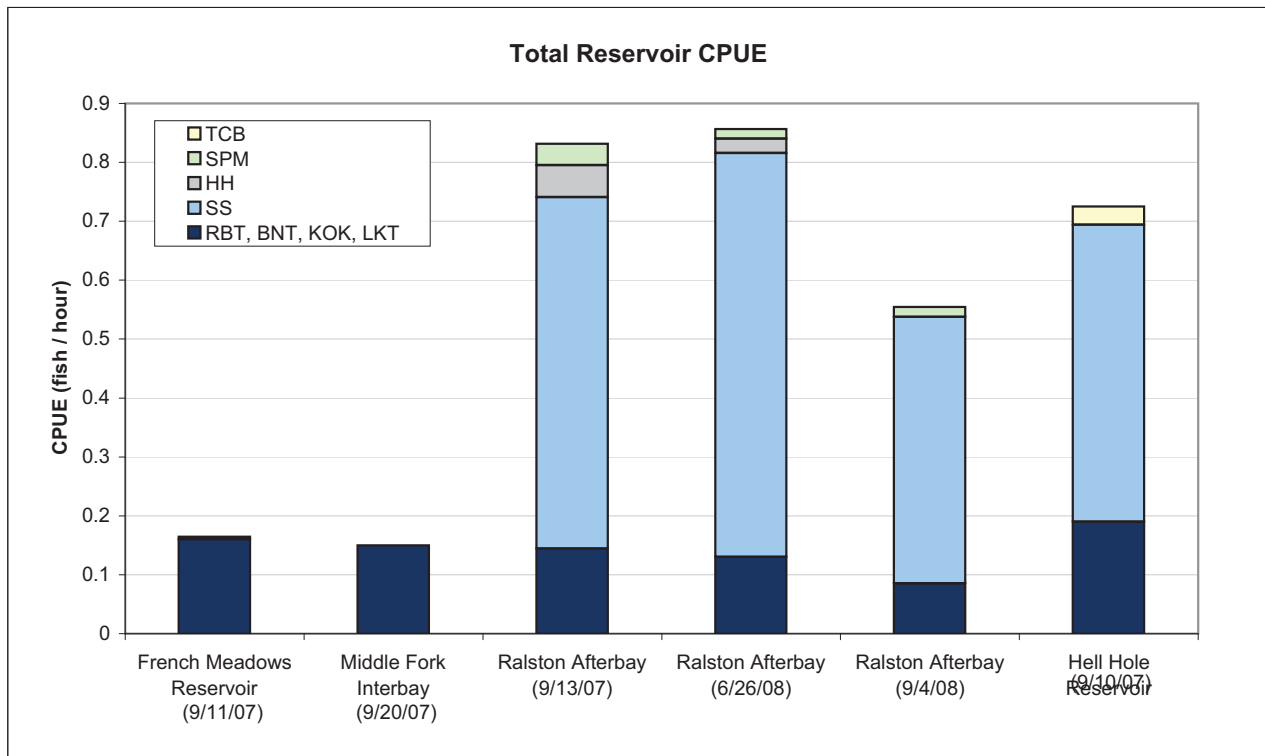
YOY: young-of-the-year

Figure AQ 2-4. 2007 Trout Density Using Reach-Extrapolated and Site-Specific Population Estimates.<sup>1</sup>



<sup>1</sup>Reach-extrapolated estimates were scaled using reach-based mesohabitat length percentages.

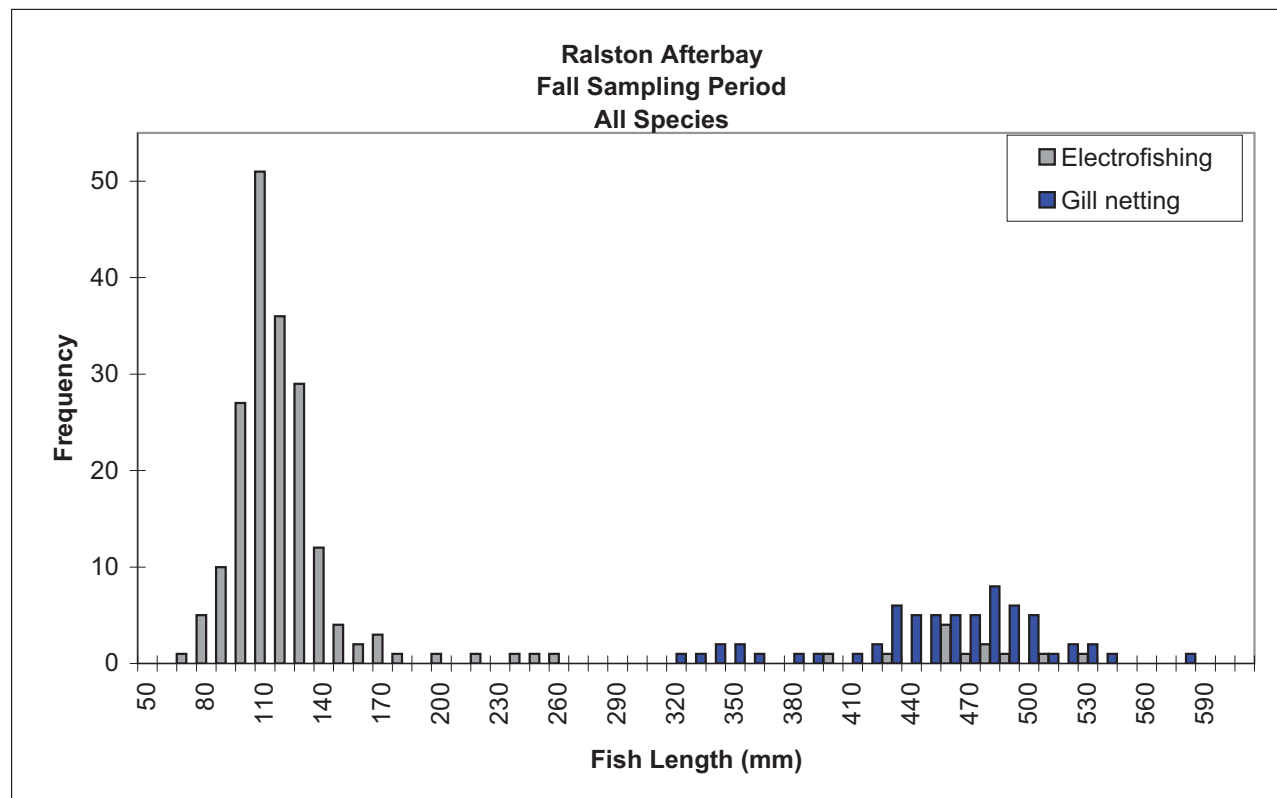
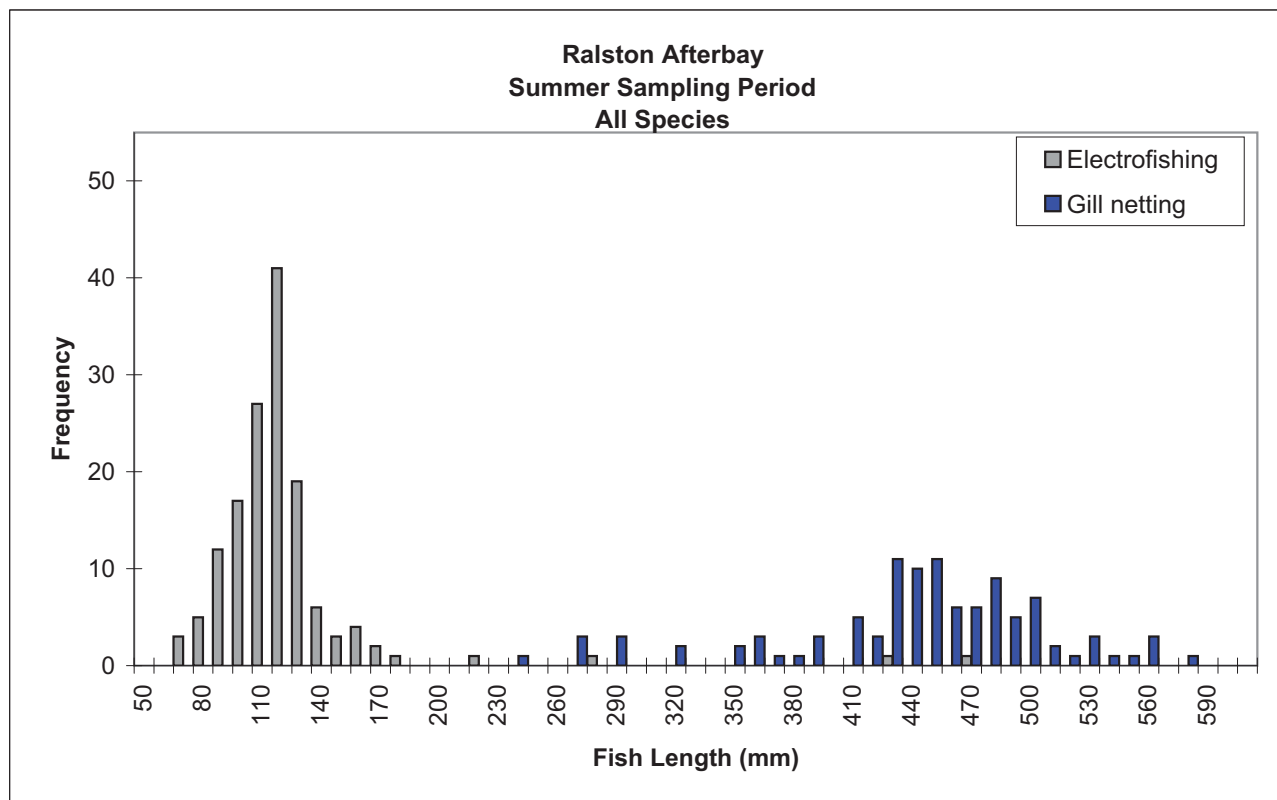
**Figure AQ 2-5. Gill Netting Catch per Unit Effort (CPUE) (Fish per Hour) for Fish Species<sup>1</sup> in Hell Hole Reservoir, French Meadows Reservoir, Middle Fork Interbay, and Ralston Afterbay.<sup>2</sup>**



<sup>1</sup>TCB = Tui Chub; SPM = Sacramento Pikeminnow; HH = Hardhead; SS = Sacramento Sucker, RBT = Rainbow Trout; BNT = Brown Trout; KOK = Kokanee Salmon; LKT = Lake Trout

<sup>2</sup>Study locations were altered on 9/4/08 for methylmercury fish tissue sampling efforts. Nets were not deployed at the bottom of the water column, fewer suckers were collected.

Figure AQ 2-6. 2008 Length Frequency Histogram of Fish Captured in Raslton Afterbay during Electrofishing and Gill Net Sampling.



**Figure AQ 2-7a. 2008 Length Frequency Histograms of Hardhead Captured from Electrofishing at Ralston Afterbay.**

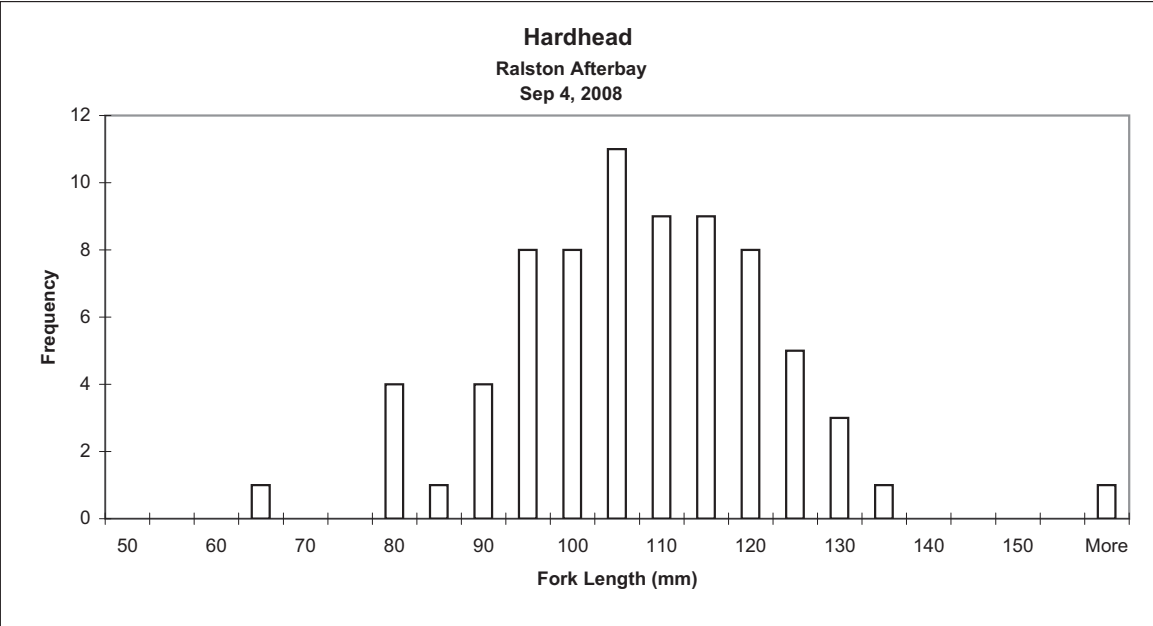
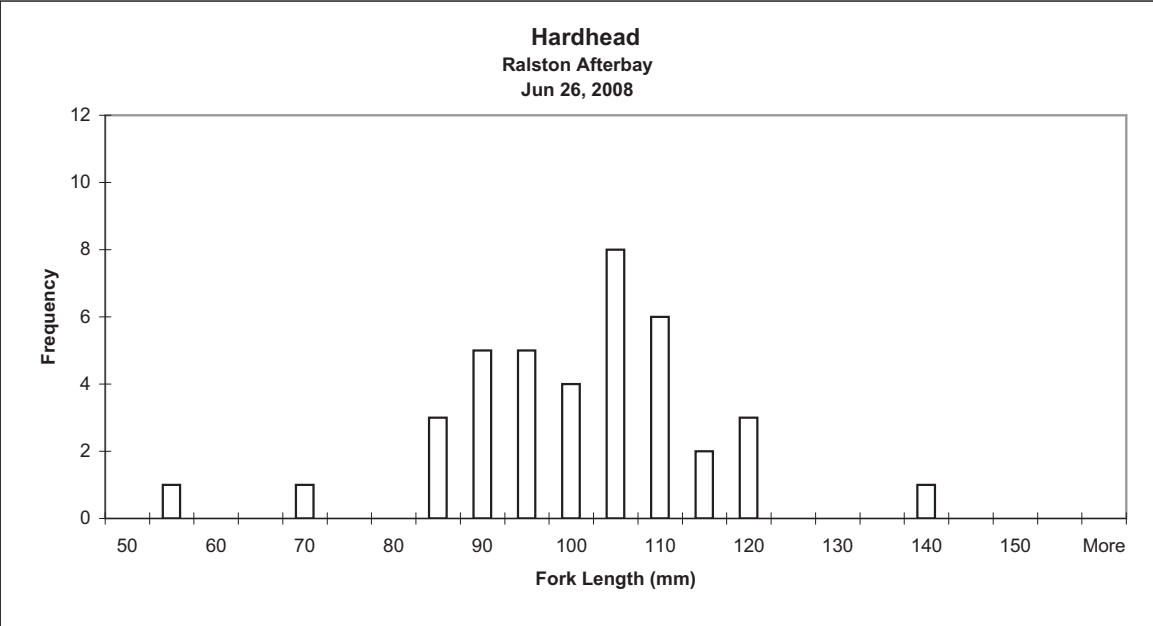
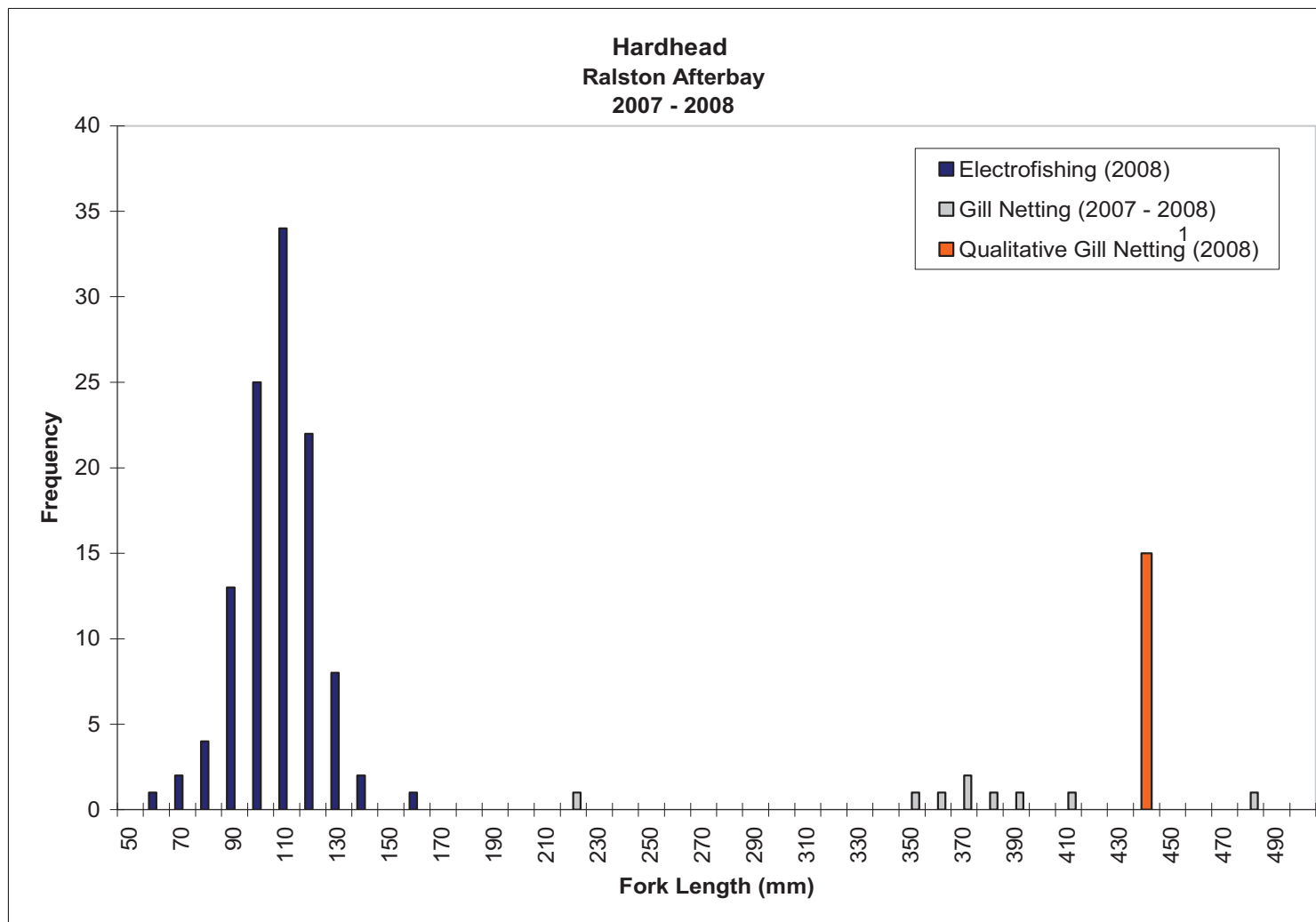
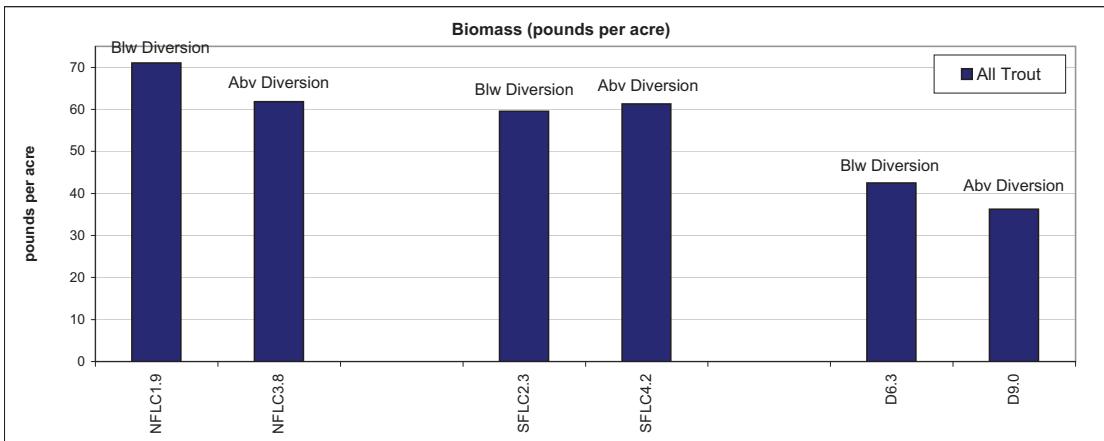
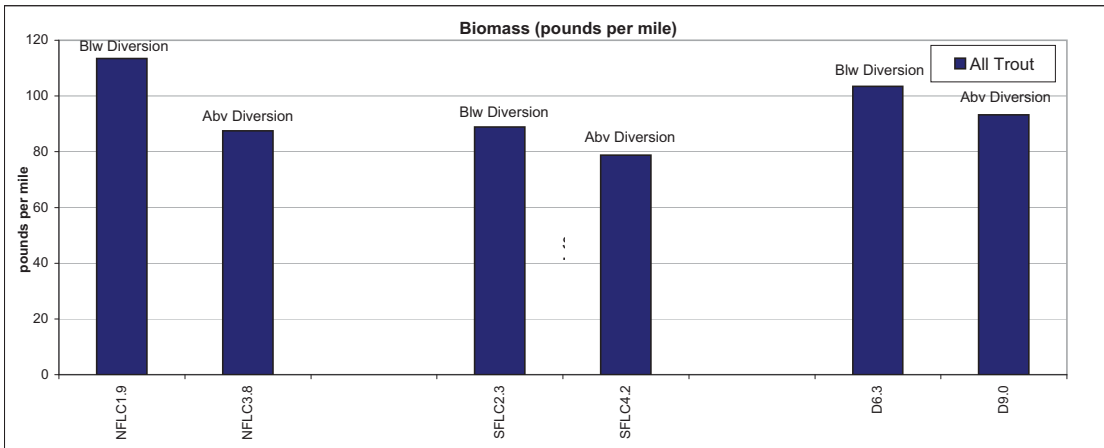
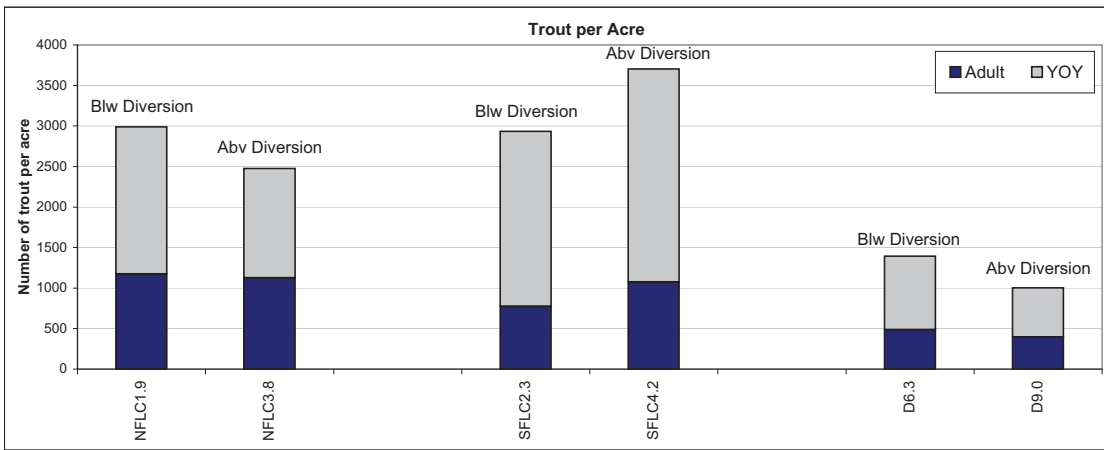
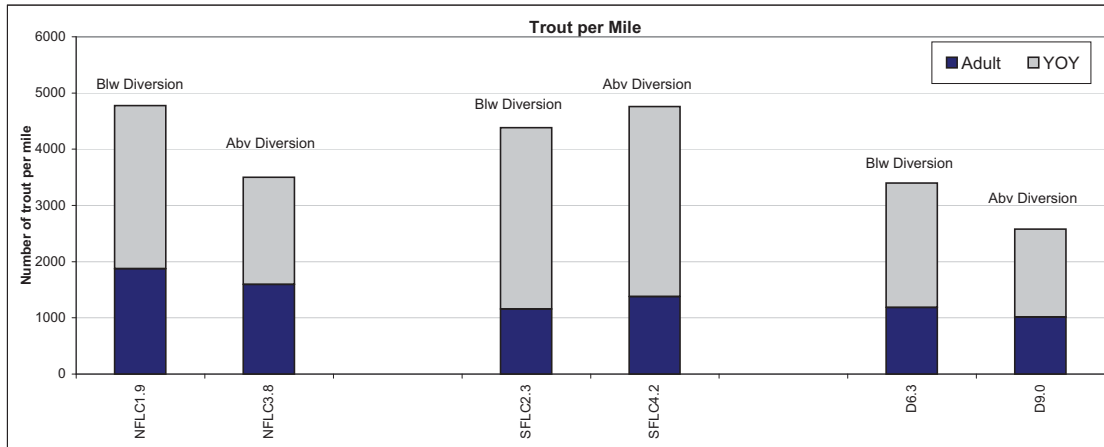


Figure AQ 2-7b. Length Frequency Histograms of All Hardhead Captured in Ralston Afterbay, Electrofishing and Gill Netting (2007 - 2008).



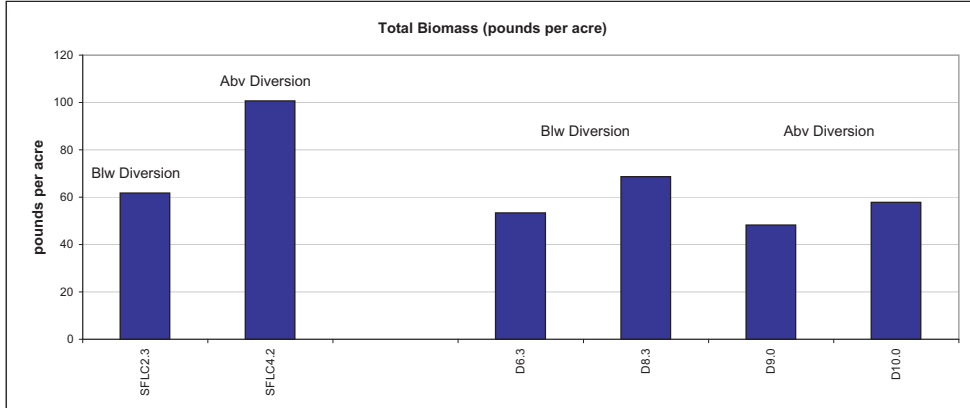
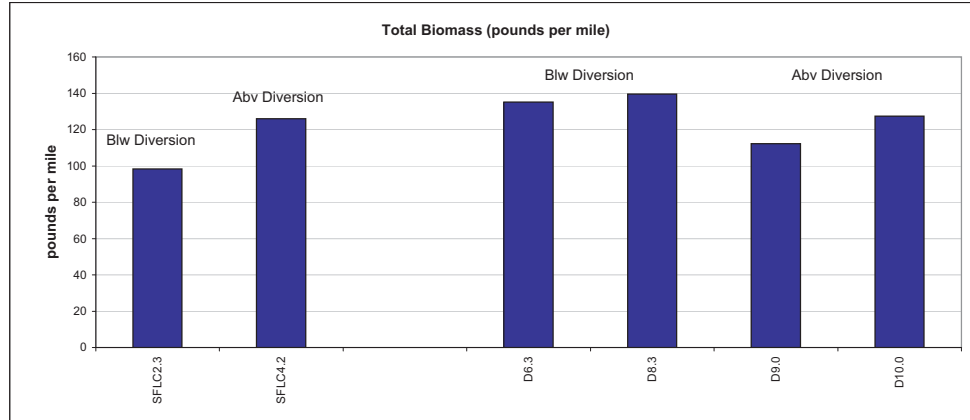
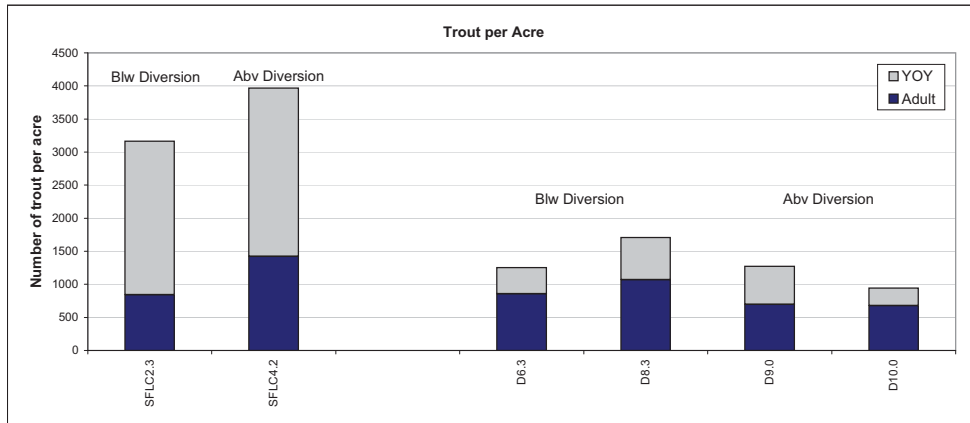
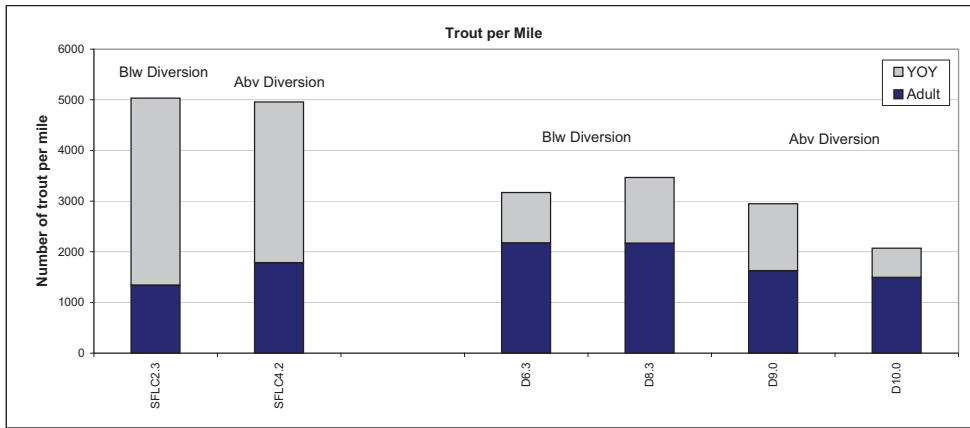
<sup>1</sup>Fifteen large hardhead were captured in a gill net during the fall 2008 qualitative trout methylmercury tissue sampling. One fish that was the approximate average size of the fish captured was measured (435 mm).

Figure AQ 2-8a. The 2007 Density and Biomass of Trout Upstream and Downstream of Small Stream Diversions.



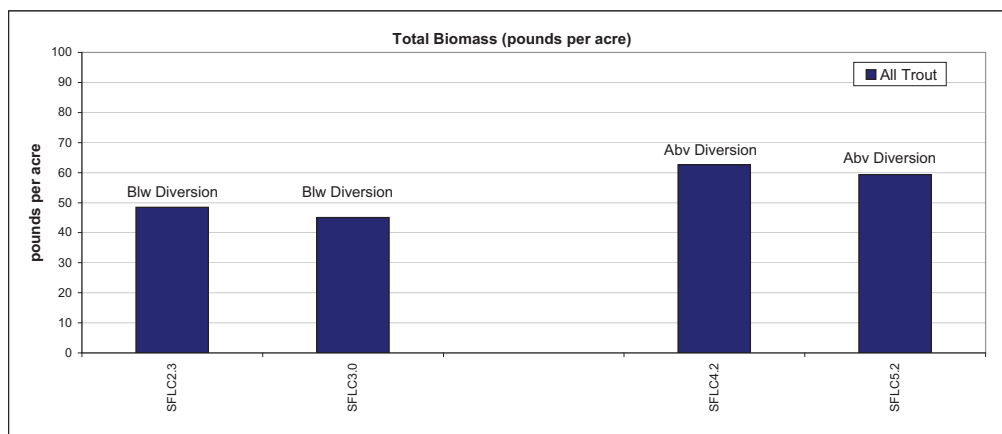
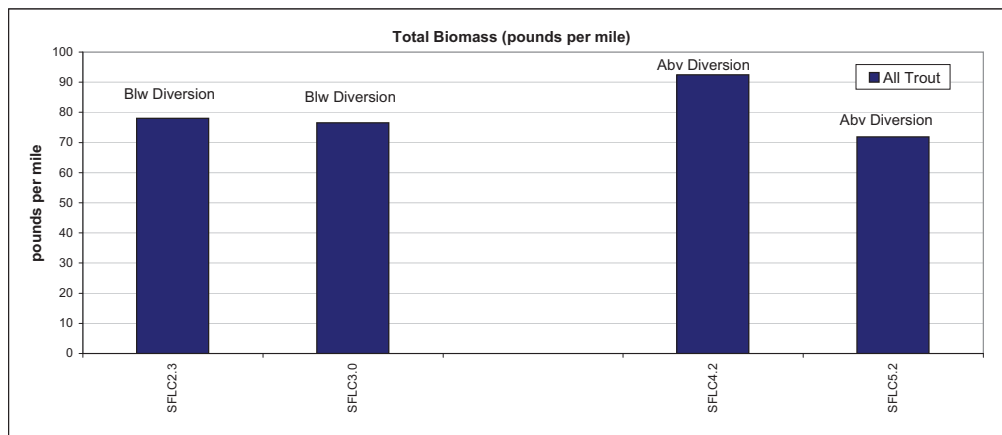
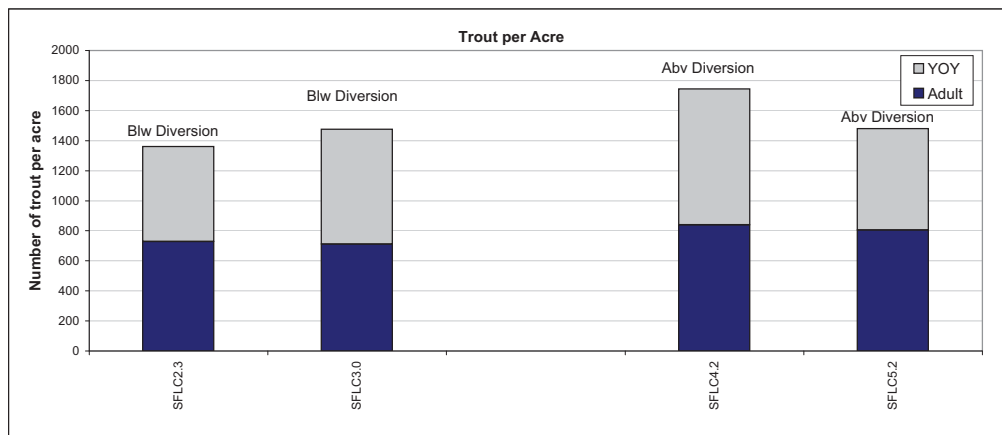
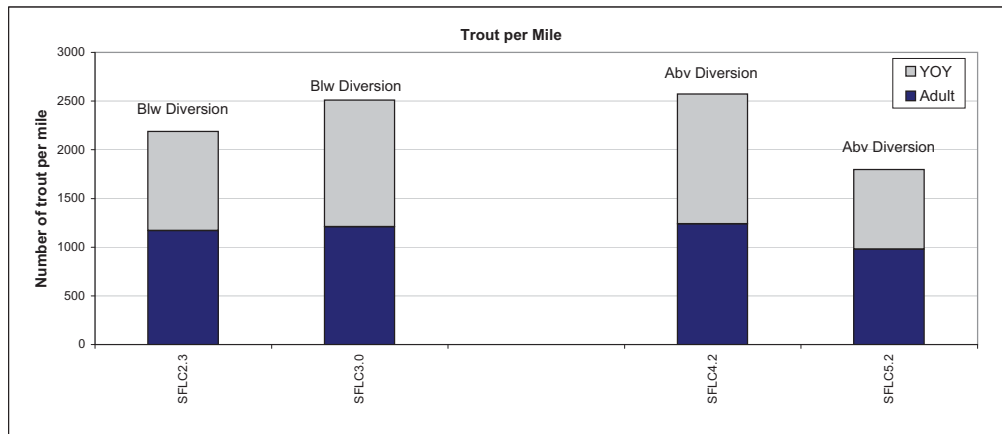
YOY: young-of-the-year

Figure AQ 2-8b. The 2008 Density and Biomass of Trout Upstream and Downstream of Small Stream Diversions.



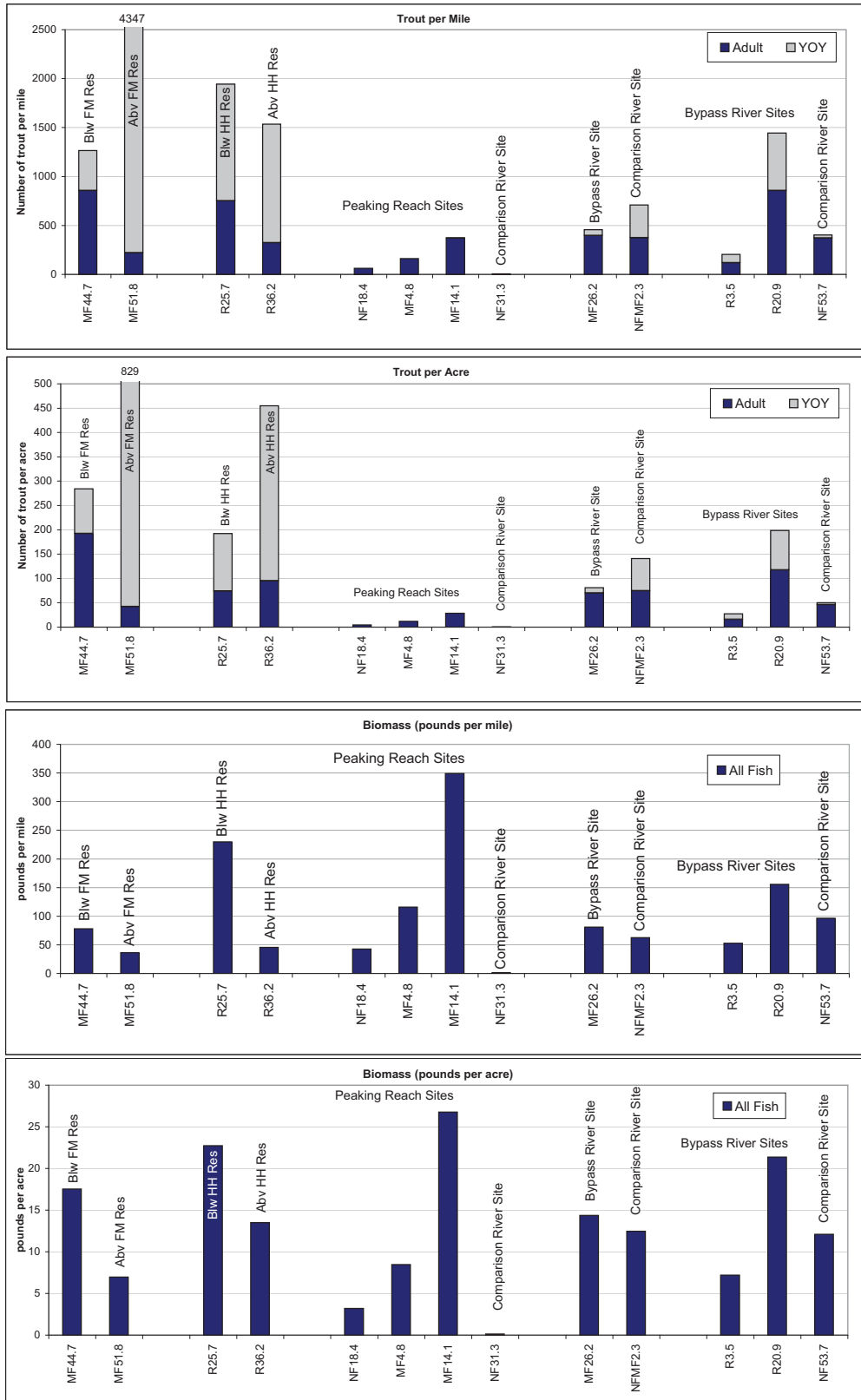
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Figure AQ 2-8c. The 2009 Density and Biomass of Trout Upstream and Downstream of Small Stream Diversions.



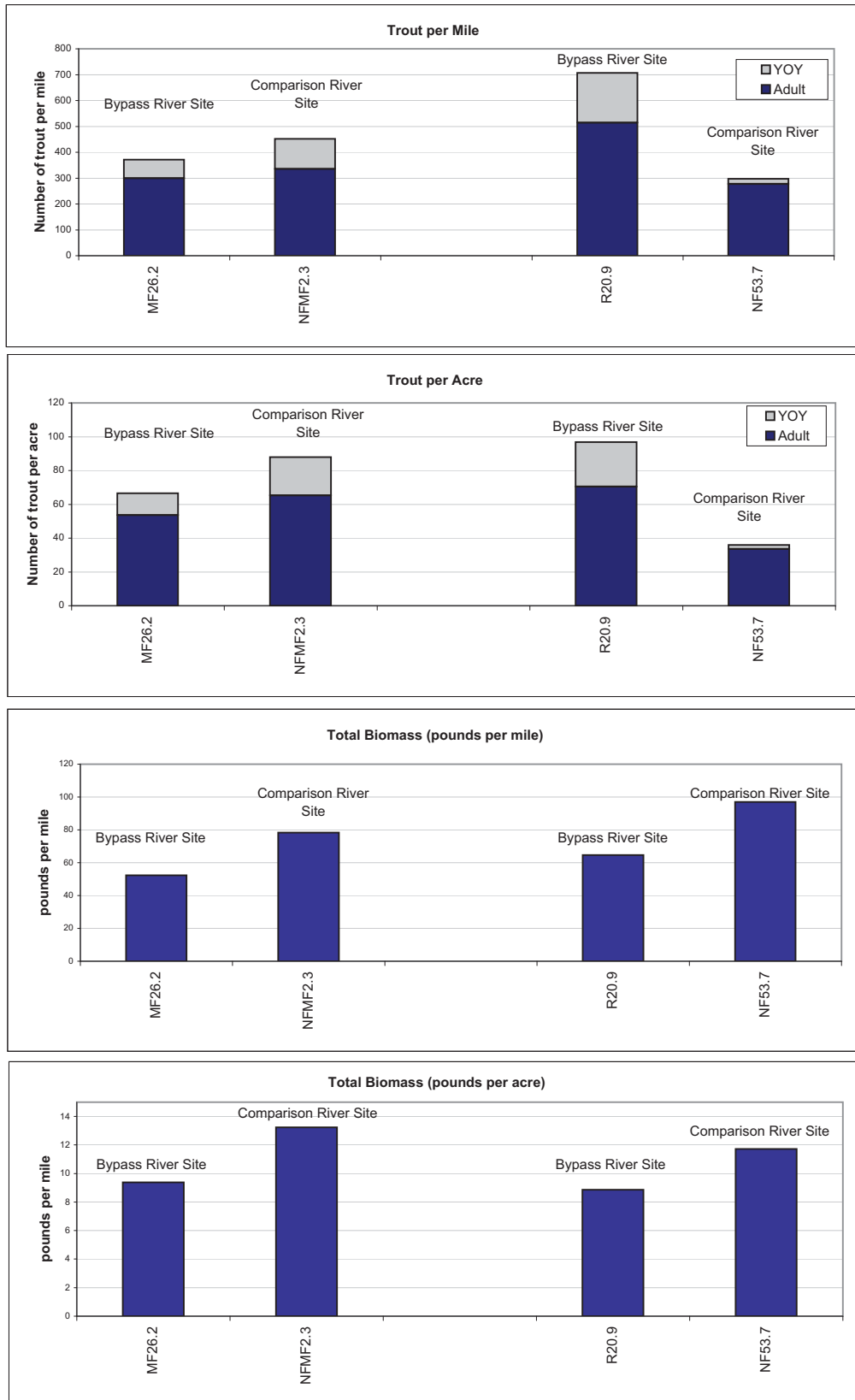
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Figure AQ 2-9a. 2007 Comparison of Trout Density and Biomass Between Study Sites and Potential Comparison Sites.



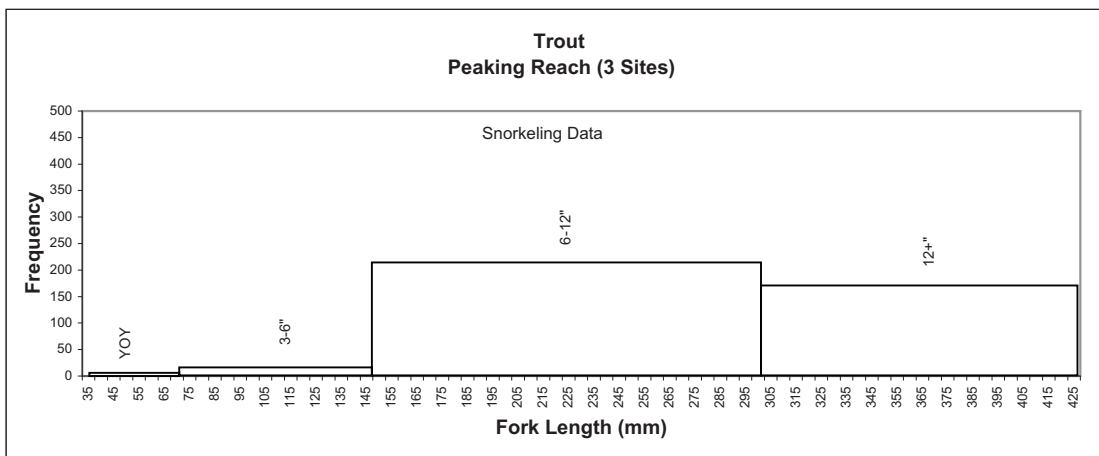
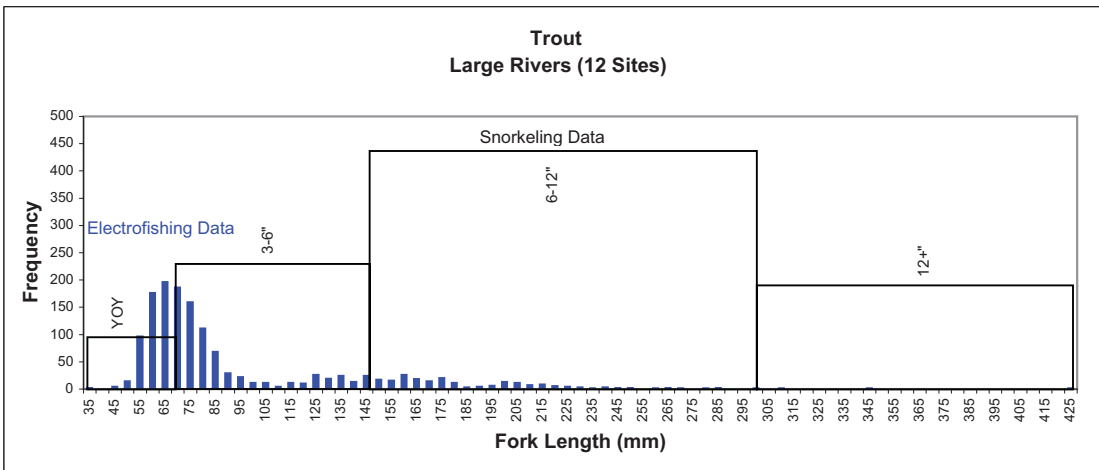
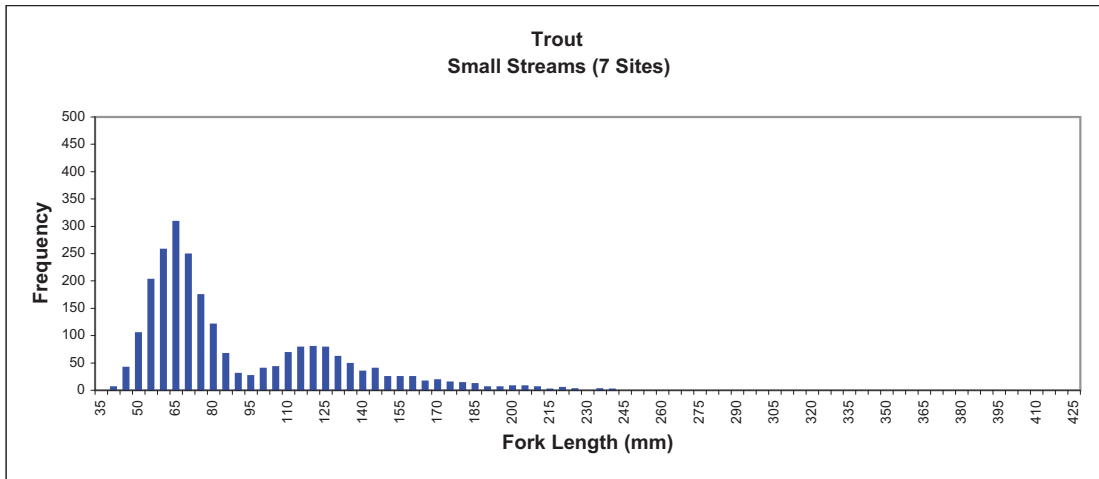
YOY: young-of-the-year

**Figure AQ 2-9b. 2008 Comparison of Trout Density and Biomass Between Study Sites and Potential Comparison Sites.**



YOY: young-of-the-year

**Figure AQ 2-10a. 2007 Length Frequency Histograms of Rainbow Trout and Brown Trout Captured During Electrofishing at Small Stream Sites<sup>1</sup> (Top), Electrofishing and Snorkeling at all Large River Sites<sup>2</sup> (Middle), and Snorkeling at all Sites in the Peaking Reach<sup>3</sup> (Bottom). (Electrofishing = Blue Bars, Snorkeling = White Bars)**

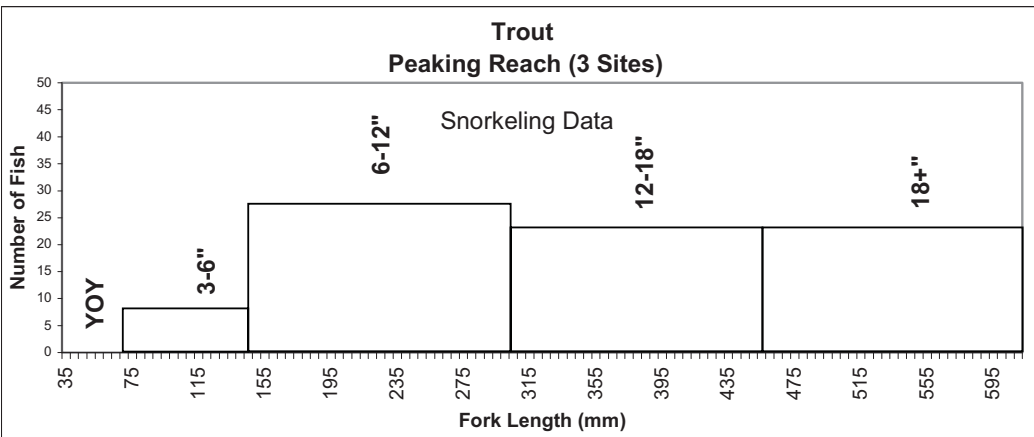
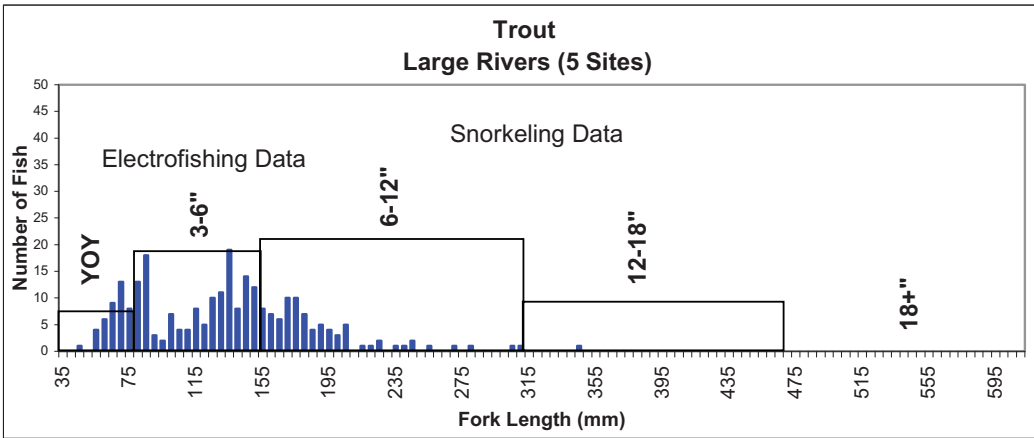
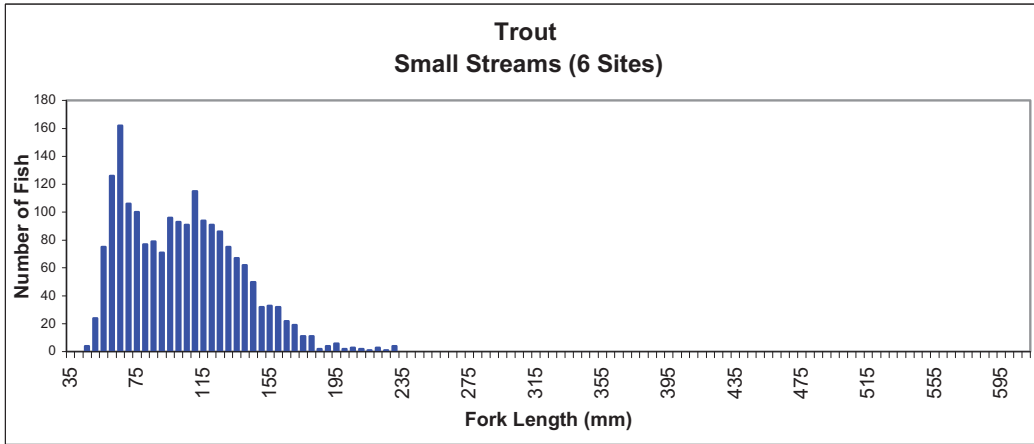


<sup>1</sup>LC9.0, NFLC1.9, NFLC3.8, SFLC2.3, SFLC4.2, D6.3, D9.0

<sup>2</sup>MF26.2, MF36.2, MF44.7, MF51.8, R3.5, R20.9, R25.7, R36.7, NFMF2.3, NF18.4, NF31.3, NF53.7

<sup>3</sup>NF18.4, MF4.8, MF14.1

**Figure AQ 2-10b. 2008 Length Frequency Histograms of Rainbow Trout and Brown Trout Captured During Electrofishing at Small Stream Sites<sup>1</sup> (Top), Electrofishing and Snorkeling at all Large River Sites<sup>2</sup> (Middle), and Snorkeling at all Sites in the Peaking Reach<sup>3</sup> (Bottom). (Electrofishing = Blue Bars, Snorkeling = White Bars)**

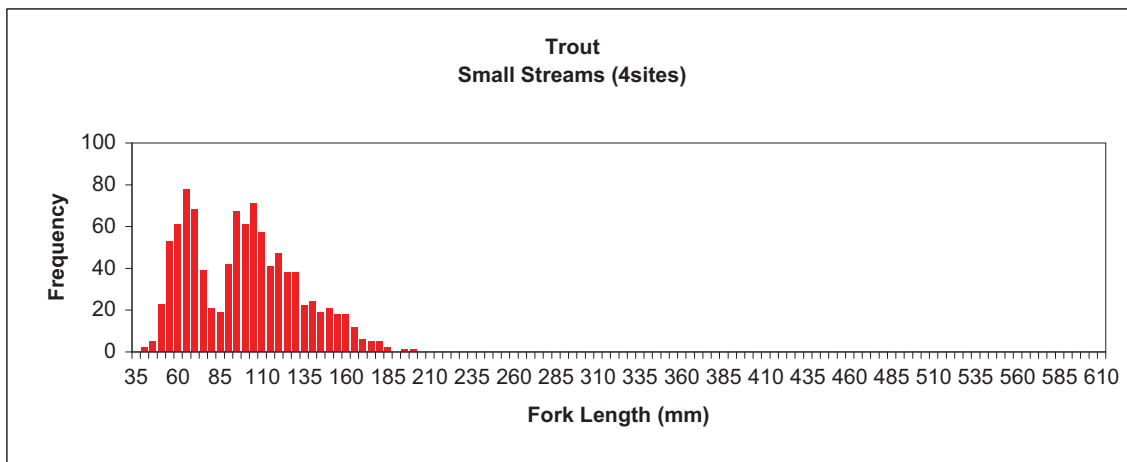


<sup>1</sup>SFLC2.3, SFLC4.2, D6.3, D8.3, D9.0, D10.0

<sup>2</sup>MF26.2, MF44.7, R20.9, NFMF2.3, NF53.7

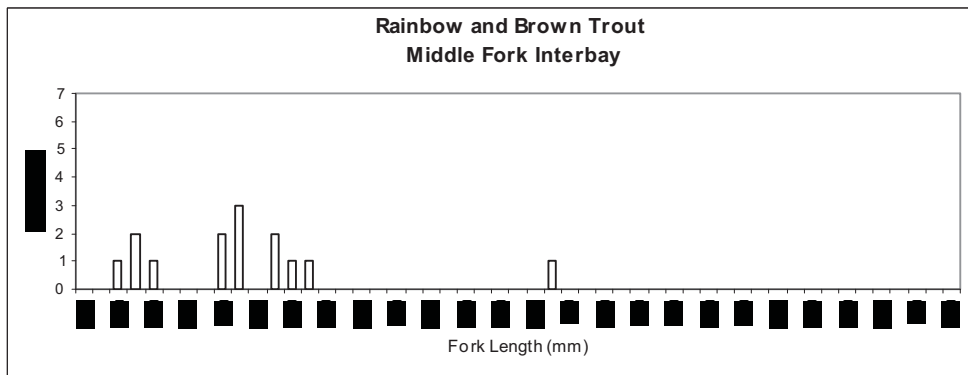
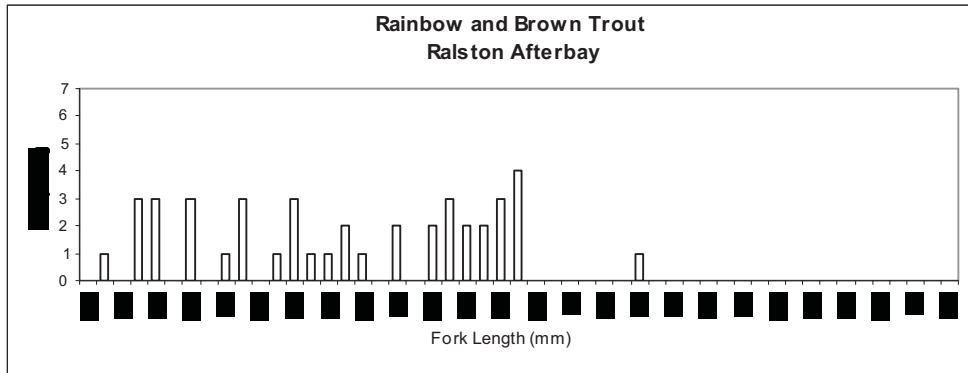
<sup>3</sup>MF4.8, MF14.1, MF23.5

Figure AQ 2-10c. 2009 Length Frequency Histograms of Rainbow Trout Captured During Electrofishing at South Fork Long Canyon Study Sites<sup>1</sup>.



<sup>1</sup>SFLC2.3, SFLC3.0, SFLC4.2, SFLC5.2

**Figure AQ 2-11. 2007-2008 Length Frequency Histograms of Rainbow Trout and Brown Trout from Gill Netting at Ralston Afterbay (Top), Middle Fork Interbay (Middle Top), French Meadows Reservoir (Middle Bottom), and Hell Hole Reservoir (Bottom).**



**Figure AQ 2-11. 2007-2008 Length Frequency Histograms of Rainbow Trout and Brown Trout from Gill Netting at Ralston Afterbay (Top), Middle Fork Interbay (Middle Top), French Meadows Reservoir (Middle Bottom), and Hell Hole Reservoir (Bottom) (continued).**

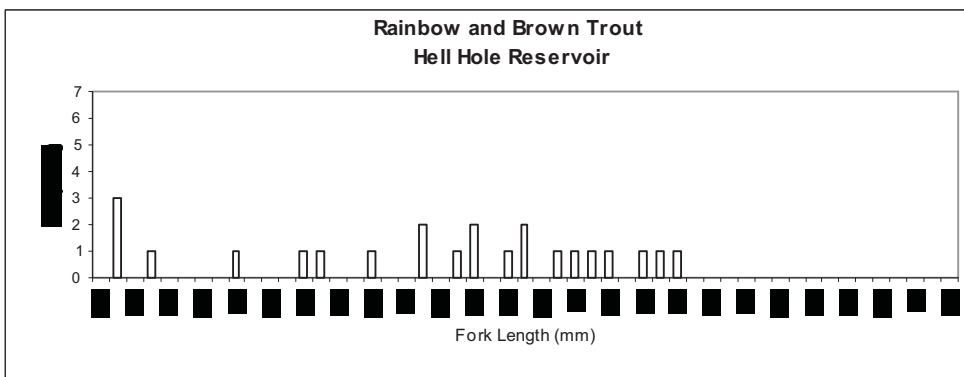
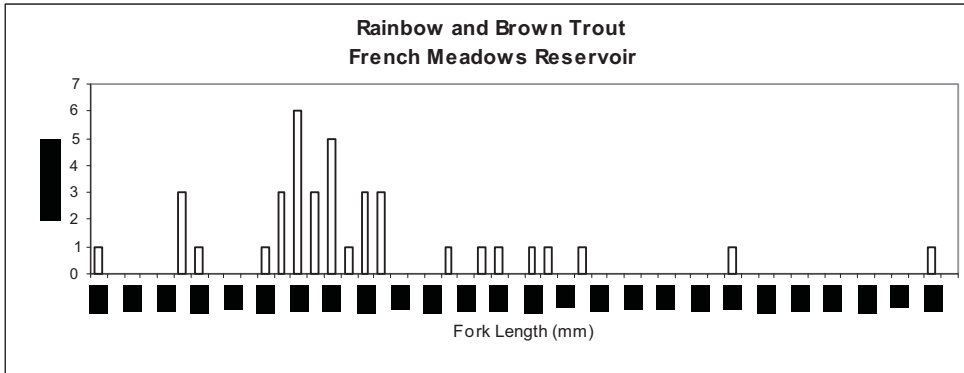


Figure AQ 2-12. 2007 Length Frequency Histograms of Kokanee Salmon From Gill Netting at Hell Hole Reservoir.

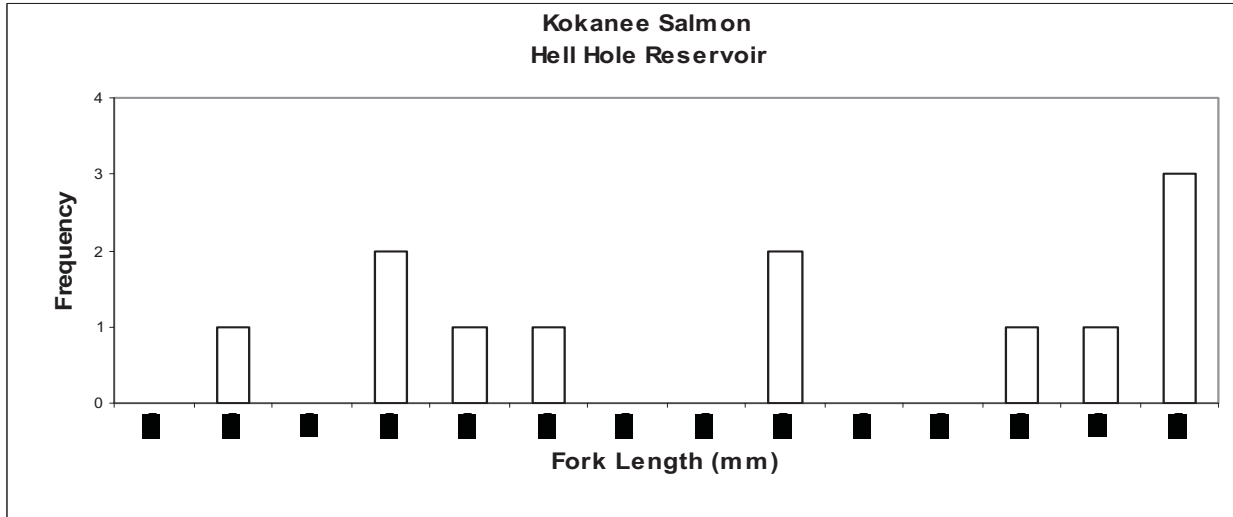
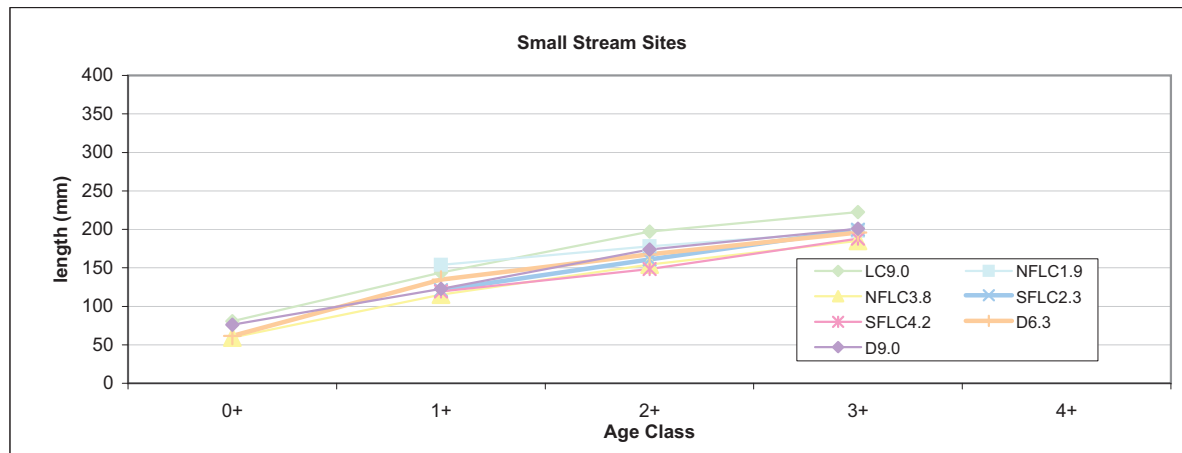
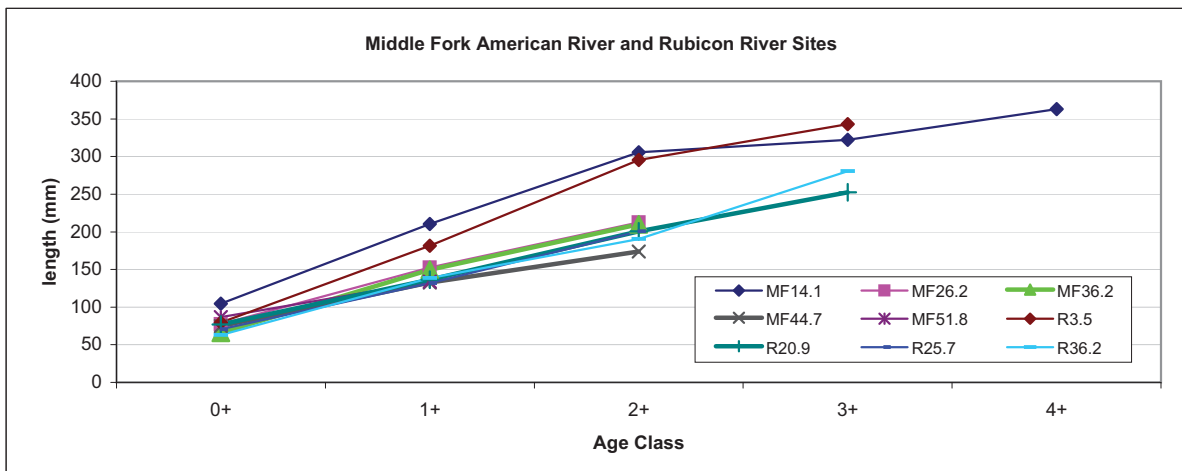
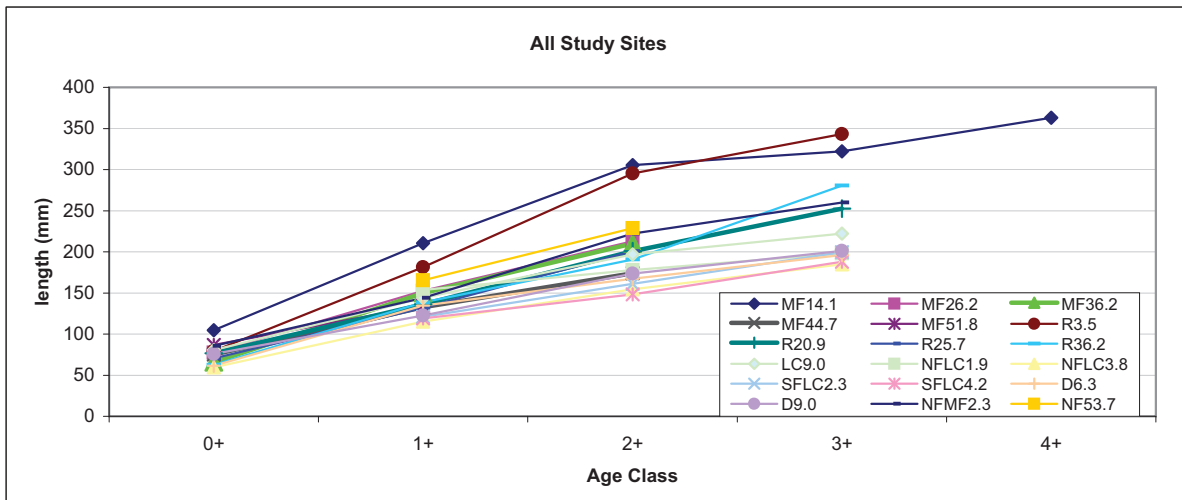
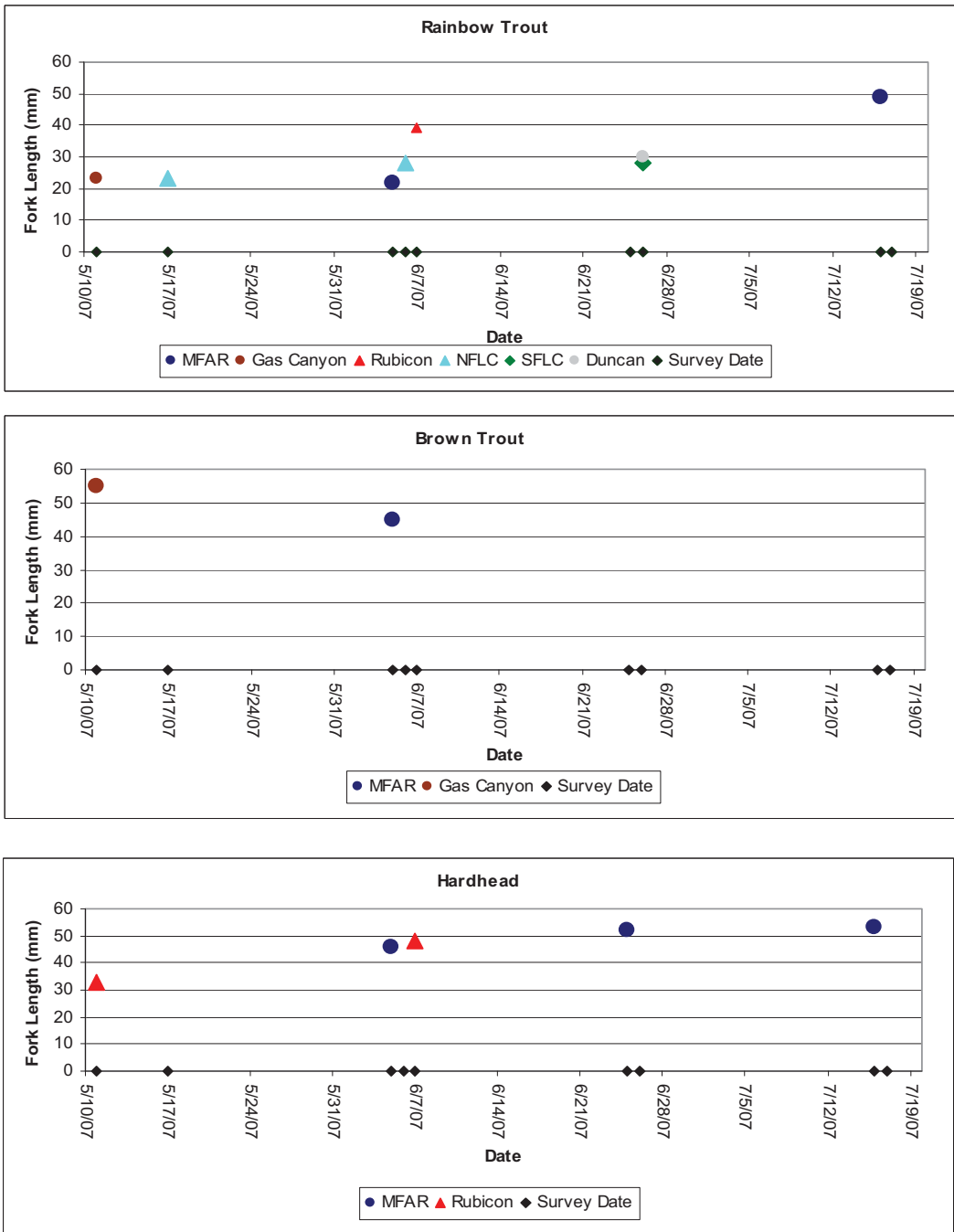


Figure AQ 2-13. 2007 Age and Growth Rates of Rainbow Trout for all Study Sites<sup>1</sup> (Top), Middle Fork American River and Rubicon River Sites (Middle), and Small Stream Sites (Bottom).



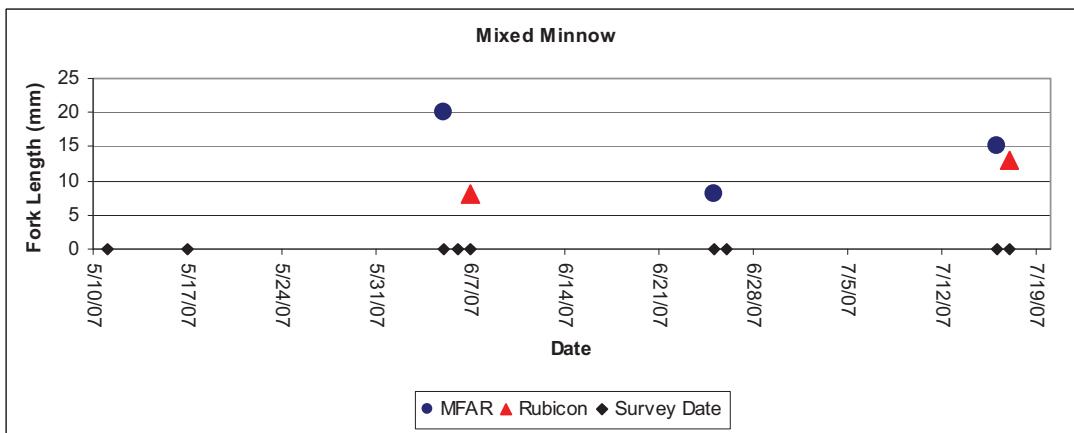
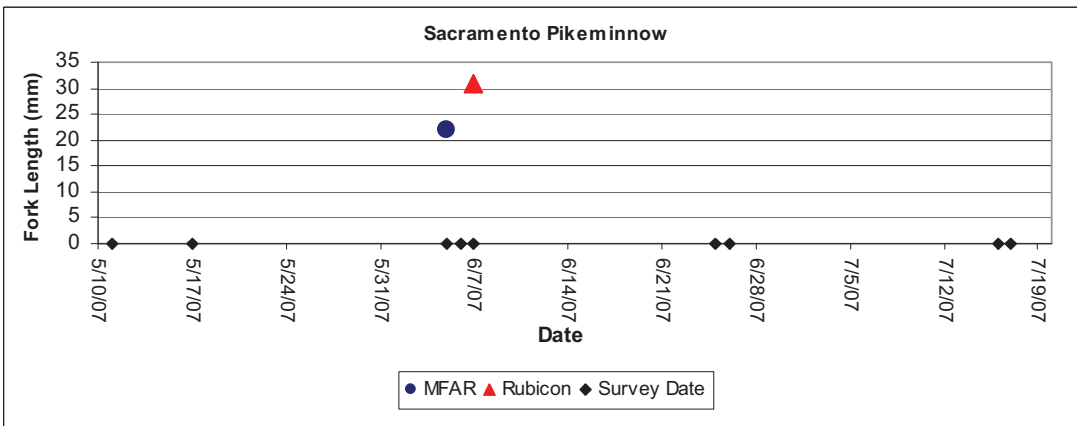
<sup>1</sup>Age and growth rate data is unavailable for sites MF4.8, NF18.4, and NF31.3

Figure AQ 2-14. 2007 Minimum Fork Lengths of Young-of-the-Year Caught during Qualitative Sampling<sup>1</sup> Sites.



<sup>1</sup>MFAR =Middle Fork American River upstream of Ralston Afterbay; Gas Canyon = Gas Canyon Creek; Rubicon = Rubicon River upstream of Ralston Powerhouse; NFLC = North Fork Long Canyon upstream of diversion pool; SFLC = South Fork Long Canyon upstream of diversion pool; Duncan =Duncan Creek usptream of diversion pool

Figure AQ 2-14. 2007 Minimum Fork Lengths of Young-of-the-Year Caught during Qualitative Sampling<sup>1</sup> Sites (continued).



<sup>1</sup>MFAR = Middle Fork American River upstream of Ralston Afterbay; Rubicon = Rubicon River upstream of Ralston Powerhouse

**MAPS**

**APPENDIX A**  
**Fish Population Sampling Site Description**

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# Middle Fork American River Downstream of Ralston Afterbay

## MF4.8 (Peaking Reach)

### 2007 & 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	474.0	120.0	56880.0	5.0	16.0	12.2%	13.0%
2	Pool	S	170.0	79.0	13430.0	4.0	12.0	4.4%	3.1%
3	Pool	S	621.0	201.0	124821.0	4.0	12.0	16.0%	28.5%
4	Pool	S	439.0	102.0	44778.0	9.0	20+	11.3%	10.2%
5	Pool	S	756.0	132.0	99792.0	5.0	16.0	19.5%	22.8%
<b>Total</b>			<b>2460.0</b>	<b>--</b>	<b>339701.0</b>	<b>--</b>	<b>--</b>	<b>63.5%</b>	<b>77.5%</b>
<b>Average</b>			<b>492.0</b>	<b>126.8</b>	<b>67940.2</b>	<b>5.4</b>	<b>14.0</b>	<b>--</b>	<b>--</b>
6	Run	S	190.0	80.0	15200.0	1.2	2.5	4.9%	3.5%
7	Run	S	456.0	42.0	19152.0	1.0	2.0	11.8%	4.4%
8	Run	S	257.0	129.0	33153.0	2.5	5.0	6.6%	7.6%
9	Run	S	514.0	60.0	30840.0	2.5	1.5	13.3%	7.0%
<b>Total</b>			<b>1417.0</b>	<b>--</b>	<b>98345.0</b>	<b>--</b>	<b>--</b>	<b>36.5%</b>	<b>22.5%</b>
<b>Average</b>			<b>354.3</b>	<b>77.8</b>	<b>24586.3</b>	<b>1.8</b>	<b>2.8</b>	<b>--</b>	<b>--</b>
<b>Grand Total</b>			<b>3877.0</b>	<b>--</b>	<b>438046.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle  
<sup>2</sup>S = Snorkeling

### Photos of Representative Habitat Units:



POOL



RUN

# Middle Fork American River Downstream of Ralston Afterbay

## MF14.1 (Peaking Reach)

2007 & 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	700.0	115.0	80500.0	2.5	7.0	20.7%	22.2%
2	Pool	S	581.0	130.0	75530.0	3.0	15.0	17.2%	20.8%
3	Pool	S	573.0	110.0	63030.0	9.0	9.0	17.0%	17.4%
4	Pool	S	303.0	74.0	22422.0	3.0	6.5	9.0%	6.2%
<b>Total</b>			<b>2157.0</b>	<b>--</b>	<b>241482.0</b>	<b>--</b>	<b>--</b>	<b>63.9%</b>	<b>66.6%</b>
<b>Average</b>			<b>539.3</b>	<b>107.3</b>	<b>60370.5</b>	<b>4.4</b>	<b>9.4</b>	<b>--</b>	<b>--</b>
5	Run	S	564.0	85.0	47940.0	1.5	3.0	16.7%	13.2%
6	Run	S	520.0	125.0	65000.0	1.0	2.0	15.4%	17.9%
<b>Total</b>			<b>1084.0</b>	<b>--</b>	<b>112940.0</b>	<b>--</b>	<b>--</b>	<b>32.1%</b>	<b>31.1%</b>
<b>Average</b>			<b>542.0</b>	<b>105.0</b>	<b>56470.0</b>	<b>1.3</b>	<b>2.5</b>	<b>--</b>	<b>--</b>
7	LGR	S	133.0	63.0	8379.0	0.8	1.3	3.9%	2.3%
<b>Total</b>			<b>133.0</b>	<b>--</b>	<b>8379.0</b>	<b>--</b>	<b>--</b>	<b>3.9%</b>	<b>2.3%</b>
<b>Grand Total</b>			<b>3374.0</b>	<b>--</b>	<b>362801.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling

Photos of Representative Habitat Units:



POOL



RUN



LGR

# Middle Fork American River Downstream of Ralston Afterbay

## MF23.5 (Peaking Reach)

2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	477	105	50085	8	25	15.9%	17.8%
2	Pool	S	387	75	29025	2.5	4	12.9%	10.3%
3	Pool	S	438	90	39420	4.5	8	14.6%	14.0%
4	Pool	S	780	120	93600	4	15	26.0%	33.2%
<b>Total</b>			<b>2082</b>	<b>--</b>	<b>212130</b>	<b>--</b>	<b>--</b>	<b>69.3%</b>	<b>75.3%</b>
<b>Average</b>			<b>520.5</b>	<b>97.5</b>	<b>53032.5</b>	<b>4.75</b>	<b>13</b>	<b>--</b>	<b>--</b>
5	Run	S	120	70.5	8460	4	4	4.0%	3.0%
6	Run	S	246	69	16974	6	6	8.2%	6.0%
7	Run	S	210	60	12600	3.5	3.5	7.0%	4.5%
<b>Total</b>			<b>576</b>	<b>--</b>	<b>38034</b>	<b>--</b>	<b>--</b>	<b>19.2%</b>	<b>13.5%</b>
<b>Average</b>			<b>192</b>	<b>66.5</b>	<b>12678</b>	<b>4.5</b>	<b>4.5</b>	<b>--</b>	<b>--</b>
8	LGR	S	126	150	18900	0.75	2	4.2%	6.7%
9	LGR	S	105	45	4725	1.5	3	3.5%	1.7%
<b>Total</b>			<b>231</b>	<b>--</b>	<b>23625</b>	<b>--</b>	<b>--</b>	<b>7.7%</b>	<b>8.4%</b>
<b>Average</b>			<b>115.5</b>	<b>97.5</b>	<b>11812.5</b>	<b>1.125</b>	<b>2.5</b>	<b>--</b>	<b>--</b>
10	HGR	S	114	70.5	8037	1.5	3	3.8%	2.9%
<b>Total</b>			<b>114</b>	<b>--</b>	<b>8037</b>	<b>--</b>	<b>--</b>	<b>3.8%</b>	<b>2.9%</b>
<b>Grand Total</b>			<b>3003</b>	<b>--</b>	<b>281826</b>	<b>--</b>	<b>--</b>	<b>100%</b>	<b>100%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling

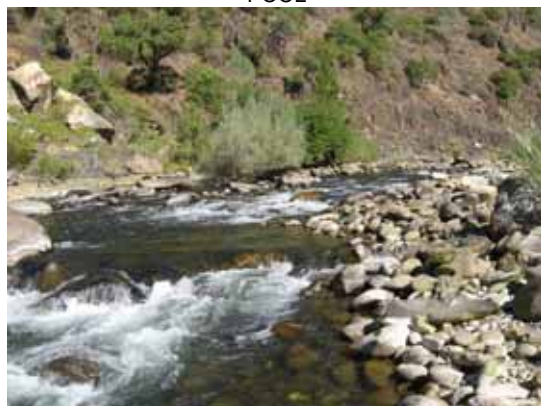
Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

## Middle Fork American River from Middle Fork Interbay to Ralston Afterbay MF26.2 (Bypass Reach)

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	232.0	51.0	11832.0	2.8	5.5	23.9%	26.2%
2	Pool	S	125.0	54.0	6750.0	4.5	7.5	12.9%	14.9%
3	Pool	S	172.0	45.0	7740.0	3.0	12.0	17.7%	17.1%
4	Pool	S	140.0	45.0	6300.0	2.6	5.0	14.4%	13.9%
<b>Total</b>			<b>669.0</b>	<b>--</b>	<b>32622.0</b>	<b>--</b>	<b>--</b>	<b>68.9%</b>	<b>72.1%</b>
<b>Average</b>			<b>167.3</b>	<b>48.8</b>	<b>8155.5</b>	<b>3.2</b>	<b>7.5</b>	<b>--</b>	<b>--</b>
5	Run	E	57.0	43.0	2451.0	1.2	2.6	5.9%	5.4%
6	Run	E	96.0	35.0	3360.0	1.6	2.6	9.9%	7.4%
<b>Total</b>			<b>153.0</b>	<b>--</b>	<b>5811.0</b>	<b>--</b>	<b>--</b>	<b>15.8%</b>	<b>12.8%</b>
<b>Average</b>			<b>76.5</b>	<b>39.0</b>	<b>2905.5</b>	<b>1.4</b>	<b>2.6</b>	<b>--</b>	<b>--</b>
7	HGR	E	99.0	45.0	4455.0	1.0	1.8	10.2%	9.8%
<b>Total</b>			<b>99.0</b>	<b>--</b>	<b>4455.0</b>	<b>--</b>	<b>--</b>	<b>10.2%</b>	<b>9.8%</b>
8	LGR	E	50.0	47.0	2350.0	0.8	1.7	5.1%	5.2%
<b>Total</b>			<b>50.0</b>	<b>--</b>	<b>2350.0</b>	<b>--</b>	<b>--</b>	<b>5.1%</b>	<b>5.2%</b>
<b>Grand Total</b>			<b>971.0</b>	<b>--</b>	<b>45238.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	232.0	51.0	11832.0	2.8	5.5	23.7%	26.2%
2	Pool	S	125.0	54.0	6750.0	4.5	7.5	12.8%	15.0%
3	Pool	S	172.0	45.0	7740.0	3	12	17.6%	17.1%
4	Pool	S	140.0	45.0	6300.0	2.6	5	14.3%	14.0%
<b>Total</b>			<b>669.0</b>	<b>--</b>	<b>32622.0</b>	<b>--</b>	<b>--</b>	<b>68.3%</b>	<b>72.3%</b>
<b>Average</b>			<b>167.3</b>	<b>48.8</b>	<b>8155.5</b>	<b>3.225</b>	<b>7.5</b>		
5	Run	E	60.0	36.0	2160.0	1.5	2.3	6.1%	4.8%
6	Run	E	101.0	45.0	4545.0	0.6	2.5	10.3%	10.1%
<b>Total</b>			<b>161.0</b>	<b>81.0</b>	<b>6705.0</b>	<b>2.1</b>	<b>4.8</b>	<b>16.4%</b>	<b>14.9%</b>
<b>Average</b>			<b>80.5</b>	<b>40.5</b>	<b>3352.5</b>	<b>1.05</b>	<b>2.4</b>		
7	HGR	E	99.0	37.0	3663.0	0.9	1.6	10.1%	8.1%
<b>Total</b>			<b>99.0</b>	<b>--</b>	<b>3663.0</b>	<b>--</b>	<b>--</b>	<b>10.1%</b>	<b>8.1%</b>
8	LGR	E	51.0	42.0	2142.0	0.8	2	5.2%	4.7%
<b>Total</b>			<b>51.0</b>	<b>--</b>	<b>2142.0</b>	<b>--</b>	<b>--</b>	<b>5.2%</b>	<b>4.7%</b>
<b>Grand Total</b>			<b>980.0</b>	<b>--</b>	<b>45132.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

**Middle Fork American River from Middle Fork Interbay to Ralston Afterbay**  
MF26.2 (Bypass Reach)

Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# Middle Fork American River Upstream of Middle Fork Interbay MF36.2 (Bypass Reach)

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	87.0	40.0	3480.0	2.0	3.5	16.3%	20.2%
2	Pool	S	80.0	30.0	2400.0	3.5	6.0	15.0%	14.0%
3	Pool	S	163.0	34.0	5542.0	1.7	4.5	30.5%	32.2%
<b>Total</b>			<b>330.0</b>	<b>--</b>	<b>11422.0</b>	<b>--</b>	<b>--</b>	<b>61.8%</b>	<b>66.4%</b>
<b>Average</b>			<b>110.0</b>	<b>34.7</b>	<b>3807.3</b>	<b>2.4</b>	<b>4.7</b>	<b>--</b>	<b>--</b>
4	Run	E	40.0	30.0	1200.0	2.1	2.8	7.5%	7.0%
5	Run	E	60.0	26.0	1560.0	1.4	4.1	11.2%	9.1%
<b>Total</b>			<b>100.0</b>	<b>--</b>	<b>2760.0</b>	<b>--</b>	<b>--</b>	<b>18.7%</b>	<b>16.0%</b>
<b>Average</b>			<b>50.0</b>	<b>28.0</b>	<b>1380.0</b>	<b>1.8</b>	<b>3.5</b>	<b>--</b>	<b>--</b>
6	HGR	E	104.0	29.0	3016.0	1.4	2.1	19.5%	17.5%
<b>Total</b>			<b>104.0</b>	<b>--</b>	<b>3016.0</b>	<b>--</b>	<b>--</b>	<b>19.5%</b>	<b>17.5%</b>
<b>Grand Total</b>			<b>534.0</b>	<b>--</b>	<b>17198.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

Photos of Representative Habitat Units:



POOL



RUN



HGR

**Middle Fork American River Upstream of Middle Fork Interbay**  
**MF44.7 (Bypass Reach)**

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	141.0	39.0	5499.0	3.0	4.6	19.9%	21.1%
2	Pool	S	132.0	45.0	5940.0	2.6	4.2	18.6%	22.8%
3	Pool	S	215.0	35.0	7525.0	2.3	3.8	30.3%	28.9%
<b>Total</b>			<b>488.0</b>	<b>--</b>	<b>18964.0</b>	<b>--</b>	<b>--</b>	<b>68.7%</b>	<b>72.8%</b>
<b>Average</b>			<b>162.7</b>	<b>39.7</b>	<b>6321.3</b>	<b>2.6</b>	<b>4.2</b>	<b>--</b>	<b>--</b>
4	Run	E	92.0	31.0	2852.0	1.6	3.5	13.0%	10.9%
<b>Total</b>			<b>92.0</b>	<b>--</b>	<b>2852.0</b>	<b>--</b>	<b>--</b>	<b>13.0%</b>	<b>10.9%</b>
5	HGR	E	80.0	36.0	2880.0	1.2	3.6	11.3%	11.1%
6	HGR	E	50.0	27.0	1350.0	1.8	3.0	7.0%	5.2%
<b>Total</b>			<b>130.0</b>	<b>--</b>	<b>4230.0</b>	<b>--</b>	<b>--</b>	<b>18.3%</b>	<b>16.2%</b>
<b>Average</b>			<b>65.0</b>	<b>31.5</b>	<b>2115.0</b>	<b>1.5</b>	<b>3.3</b>	<b>--</b>	<b>--</b>
<b>Grand Total</b>			<b>710.0</b>	<b>--</b>	<b>26046.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	143.0	30.0	4290.0	2.5	4.0	22.8%	26.0%
2	Pool	S	127.5	30.0	3825.0	2.5	5.0	20.3%	23.2%
3	Pool	S	120.0	25.0	3000.0	2.0	3.5	19.1%	18.2%
<b>Total</b>			<b>390.5</b>	<b>--</b>	<b>11115.0</b>	<b>--</b>	<b>--</b>	<b>62.1%</b>	<b>67.3%</b>
<b>Average</b>			<b>130.2</b>	<b>28.3</b>	<b>3705.0</b>	<b>2.3</b>	<b>4.2</b>	<b>--</b>	<b>--</b>
4	Run	E	101.0	24.0	2424.0	1.7	3.4	16.1%	14.7%
<b>Total</b>			<b>101.0</b>	<b>--</b>	<b>2424.0</b>	<b>--</b>	<b>--</b>	<b>16.1%</b>	<b>14.7%</b>
5	HGR	E	87.0	25.0	2175.0	1.5	4.0	13.8%	13.2%
6	HGR	E	50.0	16.0	800.0	1.5	2.7	8.0%	4.8%
<b>Total</b>			<b>137.0</b>	<b>--</b>	<b>2975.0</b>	<b>--</b>	<b>--</b>	<b>21.8%</b>	<b>18.0%</b>
<b>Average</b>			<b>68.5</b>	<b>20.5</b>	<b>1487.5</b>	<b>1.5</b>	<b>3.4</b>	<b>--</b>	<b>--</b>
<b>Grand Total</b>			<b>628.5</b>	<b>--</b>	<b>16514.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

**Middle Fork American River Upstream of Middle Fork Interbay**  
MF44.7 (Bypass Reach)

Photos of Representative Habitat Units:



POOL



Run



HGR

## Middle Fork American River Upstream of Middle Fork Interbay

MF51.8 (Comparison Reach above French Meadows Reservoir)

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	158.0	44.0	6952.0	1.3	2.5	23.9%	24.4%
2	Pool	E	120.0	39.0	4680.0	1.5	3.1	18.2%	16.4%
3	Pool	E	75.0	36.0	2700.0	1.4	2.5	11.4%	9.5%
<b>Total</b>			<b>353.0</b>	<b>--</b>	<b>14332.0</b>	<b>--</b>	<b>--</b>	<b>53.5%</b>	<b>50.2%</b>
<b>Average</b>			<b>117.7</b>	<b>39.7</b>	<b>4777.3</b>	<b>1.4</b>	<b>2.7</b>	<b>--</b>	<b>--</b>
4	Run	E	105.0	42.0	4410.0	0.7	1.5	15.9%	15.4%
5	Run	E	82.0	42.0	3444.0	0.4	1.4	12.4%	12.1%
<b>Total</b>			<b>187.0</b>	<b>--</b>	<b>7854.0</b>	<b>--</b>	<b>--</b>	<b>28.3%</b>	<b>27.5%</b>
<b>Average</b>			<b>93.5</b>	<b>42.0</b>	<b>3927.0</b>	<b>0.6</b>	<b>1.5</b>	<b>--</b>	<b>--</b>
6	LGR	E	120.0	53.0	6360.0	0.4	1.4	18.2%	22.3%
<b>Total</b>			<b>213.5</b>	<b>--</b>	<b>10287.0</b>	<b>--</b>	<b>--</b>	<b>32.3%</b>	<b>36.0%</b>
<b>Grand Total</b>			<b>660.0</b>	<b>--</b>	<b>28546.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

Photos of Representative Habitat Units:



POOL



RUN



LGR

# Rubicon River

## R3.5 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	150.0	55.0	8250.0	*	*	10.5%	9.5%
2	Pool	S	423.0	65.0	27495.0	2.5	12.0	29.6%	31.7%
3	Pool	S	105.0	48.0	5040.0	2.0	4.5	7.4%	5.8%
4	Pool	S	365.0	55.0	20075.0	4.5	14.0	25.6%	23.2%
<b>Total</b>			<b>1043.0</b>	<b>--</b>	<b>60860.0</b>	<b>--</b>	<b>--</b>	<b>73.1%</b>	<b>70.2%</b>
<b>Average</b>			<b>260.8</b>	<b>55.8</b>	<b>15215.0</b>	<b>3.0</b>	<b>10.2</b>	<b>--</b>	<b>--</b>
5	Run	S	132.0	75.0	9900.0	*	*	9.3%	11.4%
6	Run	E	96.0	63.0	6048.0	1.5	3.2	6.7%	7.0%
<b>Total</b>			<b>228.0</b>	<b>--</b>	<b>15948.0</b>	<b>--</b>	<b>--</b>	<b>16.0%</b>	<b>18.4%</b>
<b>Average</b>			<b>114.0</b>	<b>69.0</b>	<b>7974.0</b>	<b>1.5</b>	<b>3.2</b>	<b>--</b>	<b>--</b>
7	HGR	E	81.0	63.0	5103.0	1.4	3.1	5.7%	5.9%
<b>Total</b>			<b>81.0</b>	<b>--</b>	<b>5103.0</b>	<b>--</b>	<b>--</b>	<b>5.7%</b>	<b>5.9%</b>
8	LGR	E	75.0	63.0	4725.0	1.0	2.2	5.3%	5.5%
<b>Total</b>			<b>75.0</b>	<b>--</b>	<b>4725.0</b>	<b>--</b>	<b>--</b>	<b>5.3%</b>	<b>5.5%</b>
<b>Grand Total</b>			<b>1427.0</b>	<b>--</b>	<b>86636.0</b>	<b>--</b>	<b>--</b>	<b>100%</b>	<b>100%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# Rubicon River

## R20.9 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	315.0	70.0	22050.0	*	18.0	25.7%	30.0%
2	Pool	S	45.0	90.0	4050.0	*	5.0	3.7%	5.5%
3	Pool	S	300.0	60.0	18000.0	2.5	5.0	24.5%	24.5%
4	Pool	S	195.0	66.0	12870.0	6.0	12.0	15.9%	17.5%
<b>Total</b>			<b>855.0</b>	<b>--</b>	<b>56970.0</b>	<b>--</b>	<b>--</b>	<b>69.9%</b>	<b>77.5%</b>
<b>Average</b>			<b>213.8</b>	<b>71.5</b>	<b>14242.5</b>	<b>4.3</b>	<b>10.0</b>	<b>--</b>	<b>--</b>
5	Run	E	93.0	36.0	3348.0	1.6	3.7	7.6%	4.6%
6	Run	S	165.0	55.0	9075.0	*	3.0	13.5%	12.3%
<b>Total</b>			<b>258.0</b>	<b>--</b>	<b>12423.0</b>	<b>--</b>	<b>--</b>	<b>21.1%</b>	<b>16.9%</b>
<b>Average</b>			<b>129.0</b>	<b>45.5</b>	<b>6211.5</b>	<b>1.6</b>	<b>3.4</b>	<b>--</b>	<b>--</b>
7	HGR	E	111.0	37.0	4107.0	1.7	4.0	9.1%	5.6%
<b>Total</b>			<b>111.0</b>	<b>--</b>	<b>4107.0</b>	<b>--</b>	<b>--</b>	<b>9.1%</b>	<b>5.6%</b>
<b>Grand Total</b>			<b>1224.0</b>	<b>--</b>	<b>73500.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

### 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	315.0	70.0	22050.0	*	18.0	25.4%	29.5%
2	Pool	S	45.0	90.0	4050.0	*	5.0	3.6%	5.4%
3	Pool	S	300.0	60.0	18000.0	2.5	5.0	24.2%	24.1%
4	Pool	S	195.0	66.0	12870.0	6.0	12.0	15.7%	17.2%
<b>Total</b>			<b>855.0</b>	<b>--</b>	<b>56970.0</b>	<b>--</b>	<b>--</b>	<b>69.0%</b>	<b>76.3%</b>
<b>Average</b>			<b>213.8</b>	<b>71.5</b>	<b>14242.5</b>	<b>4.3</b>	<b>10.0</b>	<b>--</b>	<b>--</b>
5	Run	E	109.0	30.0	3270.0	1.4	3.4	8.8%	4.4%
6	Run	S	165.0	55.0	9075.0	*	3.0	13.3%	12.2%
<b>Total</b>			<b>274.0</b>	<b>--</b>	<b>12345.0</b>	<b>--</b>	<b>--</b>	<b>22.1%</b>	<b>16.5%</b>
<b>Average</b>			<b>137.0</b>	<b>42.5</b>	<b>6172.5</b>	<b>1.4</b>	<b>3.2</b>	<b>--</b>	<b>--</b>
7	HGR	E	111.0	48.0	5328.0	1.9	3.5	9.0%	7.1%
<b>Total</b>			<b>111.0</b>	<b>--</b>	<b>5328.0</b>	<b>--</b>	<b>--</b>	<b>9.0%</b>	<b>7.1%</b>
<b>Grand Total</b>			<b>1240.0</b>	<b>--</b>	<b>74643.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

**Rubicon River**  
R20.9 (Bypass Reach)

Photos of Representative Habitat Units:



POOL



RUN



HGR

# Rubicon River

## R25.7 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	60.0	237.0	14220.0	2.0	8.0	14.5%	41.3%
2	Pool	S	33.0	216.0	7128.0	2.0	5.5	8.0%	20.7%
3	Pool	S	52.0	54.0	2808.0	3.5	6.0	12.6%	8.2%
<b>Total</b>			<b>145.0</b>	<b>--</b>	<b>24156.0</b>	<b>--</b>	<b>--</b>	<b>35.1%</b>	<b>70.2%</b>
<b>Average</b>			<b>48.3</b>	<b>169.0</b>	<b>8052.0</b>	<b>2.5</b>	<b>6.5</b>	<b>--</b>	<b>--</b>
4	Run	E	75.0	29.0	2175.0	1.8	3.1	18.2%	6.3%
5	Run	E	69.0	45.0	3105.0	1.3	2.4	16.7%	9.0%
<b>Total</b>			<b>144.0</b>	<b>--</b>	<b>5280.0</b>	<b>--</b>	<b>--</b>	<b>34.9%</b>	<b>15.4%</b>
<b>Average</b>			<b>72.0</b>	<b>37.0</b>	<b>2640.0</b>	<b>1.6</b>	<b>2.8</b>	<b>--</b>	<b>--</b>
6	HGR	E	62.0	39.0	2418.0	1.0	2.1	15.0%	7.0%
<b>Total</b>			<b>62.0</b>	<b>--</b>	<b>2418.0</b>	<b>--</b>	<b>--</b>	<b>15.0%</b>	<b>7.0%</b>
7	LGR	E	62.0	41.0	2542.0	0.8	2.5	15.0%	7.4%
<b>Total</b>			<b>62.0</b>	<b>--</b>	<b>2542.0</b>	<b>--</b>	<b>--</b>	<b>15.0%</b>	<b>7.4%</b>
<b>Grand Total</b>			<b>413.0</b>	<b>--</b>	<b>34396.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

### Photos of Representative Habitat Units:



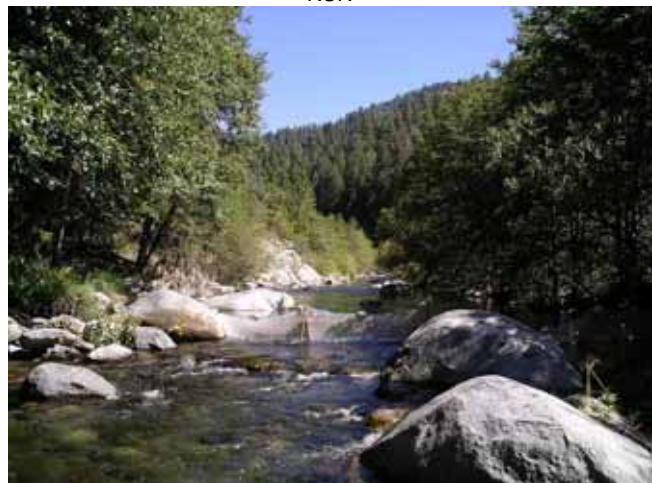
POOL



RUN



HGR



LGR

# Rubicon River

## R36.2 (Comparison Reach above Hell Hole Reservoir)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	132.0	25.0	3300.0	2.3	4.6	19.2%	17.2%
2	Pool	E	130.0	13.0	1690.0	*	*	18.9%	8.8%
3	Pool	E	240.0	45.0	10800.0	1.8	3.3	34.9%	56.4%
<b>Total</b>			<b>502.0</b>	<b>--</b>	<b>15790.0</b>	<b>--</b>	<b>--</b>	<b>73.0%</b>	<b>82.5%</b>
<b>Average</b>			<b>167.3</b>	<b>27.7</b>	<b>5263.3</b>	<b>2.1</b>	<b>4.0</b>	<b>--</b>	<b>--</b>
4	Run	E	72.0	7.0	504.0	0.3	0.6	10.5%	2.6%
5	Run	E	50.0	11.0	550.0	0.5	1.0	7.3%	2.9%
<b>Total</b>			<b>122.0</b>	<b>--</b>	<b>1054.0</b>	<b>--</b>	<b>--</b>	<b>17.7%</b>	<b>5.5%</b>
<b>Average</b>			<b>61.0</b>	<b>9.0</b>	<b>527.0</b>	<b>0.4</b>	<b>0.8</b>	<b>--</b>	<b>--</b>
6	HGR	E	64.0	36.0	2304.0	0.5	1.3	9.3%	12.0%
<b>Total</b>			<b>64.0</b>	<b>--</b>	<b>2304.0</b>	<b>--</b>	<b>--</b>	<b>9.3%</b>	<b>12.0%</b>
<b>Grand Total</b>			<b>688.0</b>	<b>--</b>	<b>19148.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



POOL



RUN



HGR

# Long Canyon Creek

## LC9.0 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	87.0	12.0	1044.0	2.5	5.5	16.0%	11.8%
2	Pool	E	72.0	16.0	1152.0	1.9	4.2	13.3%	13.1%
3	Pool	E	150.0	18.0	2700.0	0.6	1.8	27.6%	30.6%
<b>Total</b>			<b>309.0</b>	<b>--</b>	<b>4896.0</b>	<b>--</b>	<b>--</b>	<b>56.9%</b>	<b>55.5%</b>
<b>Average</b>			<b>103.0</b>	<b>15.3</b>	<b>1632.0</b>	<b>1.7</b>	<b>3.8</b>	<b>--</b>	<b>--</b>
4	Run	E	63.0	15.0	945.0	0.8	1.8	11.6%	10.7%
<b>Total</b>			<b>63.0</b>	<b>--</b>	<b>945.0</b>	<b>--</b>	<b>--</b>	<b>11.6%</b>	<b>10.7%</b>
5	HGR	E	67.0	15.0	1005.0	0.5	0.9	12.3%	11.4%
<b>Total</b>			<b>67.0</b>	<b>--</b>	<b>1005.0</b>	<b>--</b>	<b>--</b>	<b>12.3%</b>	<b>11.4%</b>
6	LGR	E	104.0	19.0	1976.0	0.6	1.6	19.2%	22.4%
<b>Total</b>			<b>104.0</b>	<b>--</b>	<b>1976.0</b>	<b>--</b>	<b>--</b>	<b>19.2%</b>	<b>22.4%</b>
<b>Grand Total</b>			<b>543.0</b>	<b>--</b>	<b>8822.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# North Fork Long Canyon Creek

## NFLC1.9 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	48.0	17.0	816.0	1.5	2.8	12.0%	15.5%
2	Pool	E	45.0	11.0	495.0	0.6	1.1	11.3%	9.4%
3	Pool	E	54.0	13.0	702.0	0.9	1.6	13.5%	13.3%
<b>Total</b>			<b>147.0</b>	<b>--</b>	<b>2013.0</b>	<b>--</b>	<b>--</b>	<b>36.8%</b>	<b>38.3%</b>
<b>Average</b>			<b>49.0</b>	<b>13.7</b>	<b>671.0</b>	<b>1.0</b>	<b>1.8</b>	<b>--</b>	<b>--</b>
4	Run	E	78.0	14.0	1092.0	0.4	1.0	19.5%	20.8%
<b>Total</b>			<b>78.0</b>	<b>--</b>	<b>1092.0</b>	<b>--</b>	<b>--</b>	<b>19.5%</b>	<b>20.8%</b>
5	HGR	E	78.0	12.0	936.0	0.3	1.0	19.5%	17.8%
<b>Total</b>			<b>78.0</b>	<b>--</b>	<b>936.0</b>	<b>--</b>	<b>--</b>	<b>19.5%</b>	<b>17.8%</b>
6	LGR	E	36.0	13.0	468.0	0.3	0.6	9.0%	8.9%
7	LGR	E	60.0	12.5	750.0	0.4	0.6	15.0%	14.3%
<b>Total</b>			<b>96.0</b>	<b>--</b>	<b>1218.0</b>	<b>--</b>	<b>--</b>	<b>24.1%</b>	<b>23.2%</b>
<b>Average</b>			<b>48.0</b>	<b>12.8</b>	<b>609.0</b>	<b>0.4</b>	<b>0.6</b>	<b>--</b>	<b>--</b>
<b>Grand Total</b>			<b>399.0</b>	<b>--</b>	<b>5259.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle  
<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# North Fork Long Canyon Creek

## NFLC3.8 (Comparison Reach above North Fork Long Canyon Diversion)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	85.0	12.0	1020.0	1.0	2.4	19.7%	20.3%
2	Pool	E	93.0	11.0	1023.0	1.6	0.5	21.6%	20.3%
3	Pool	E	25.0	16.0	400.0	0.8	1.7	5.8%	7.9%
<b>Total</b>			<b>203.0</b>	<b>--</b>	<b>2443.0</b>	<b>--</b>	<b>--</b>	<b>47.1%</b>	<b>48.5%</b>
<b>Average</b>			<b>67.7</b>	<b>13.0</b>	<b>814.3</b>	<b>1.1</b>	<b>1.5</b>	<b>--</b>	<b>--</b>
4	Run	E	60.0	14.0	840.0	0.4	1.2	13.9%	16.7%
<b>Total</b>			<b>60.0</b>	<b>--</b>	<b>840.0</b>	<b>--</b>	<b>--</b>	<b>14%</b>	<b>17%</b>
5	HGR	E	57.0	10.0	570.0	0.4	0.8	13.2%	11.3%
6	HGR	E	45.0	13.0	585.0	0.3	0.6	10.4%	11.6%
<b>Total</b>			<b>102.0</b>	<b>--</b>	<b>1155.0</b>	<b>--</b>	<b>--</b>	<b>23.7%</b>	<b>23.0%</b>
<b>Average</b>			<b>51.0</b>	<b>11.5</b>	<b>577.5</b>	<b>0.3</b>	<b>0.7</b>	<b>--</b>	<b>--</b>
7	LGR	E	66.0	9.0	594.0	0.3	0.7	15.3%	11.8%
<b>Total</b>			<b>66.0</b>	<b>--</b>	<b>594.0</b>	<b>--</b>	<b>--</b>	<b>15.3%</b>	<b>11.8%</b>
<b>Grand Total</b>			<b>431.0</b>	<b>--</b>	<b>5032.0</b>	<b>--</b>	<b>--</b>	<b>100%</b>	<b>100%</b>

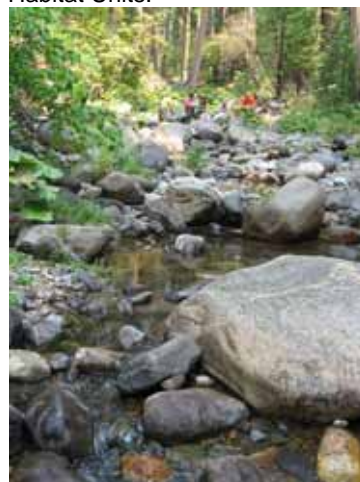
<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# South Fork Long Canyon Creek

## SFLC2.3 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	90.0	15.0	1350.0	1.0	2.4	16.2%	19.7%
2	Pool	E	101.0	12.5	1262.5	1.8	2.5	18.2%	18.5%
3	Pool	E	96.0	14.0	1344.0	0.8	2.1	17.3%	19.6%
<b>Total</b>			<b>287.0</b>	<b>--</b>	<b>3956.5</b>	<b>--</b>	<b>--</b>	<b>51.7%</b>	<b>57.8%</b>
<b>Average</b>			<b>95.7</b>	<b>13.8</b>	<b>1318.8</b>	<b>1.2</b>	<b>2.3</b>	<b>--</b>	<b>--</b>
4	Run	E	64.0	8.7	556.8	0.5	0.8	11.5%	8.1%
5	Run	E	52.0	17.5	910.0	0.4	0.7	9.4%	13.3%
<b>Total</b>			<b>116.0</b>	<b>--</b>	<b>1466.8</b>	<b>--</b>	<b>--</b>	<b>20.9%</b>	<b>21.4%</b>
<b>Average</b>			<b>58.0</b>	<b>13.1</b>	<b>733.4</b>	<b>0.4</b>	<b>0.8</b>	<b>--</b>	<b>--</b>
6	HGR	E	65.0	10.3	669.5	0.3	0.9	11.7%	9.8%
<b>Total</b>			<b>65.0</b>	<b>--</b>	<b>669.5</b>	<b>--</b>	<b>--</b>	<b>11.7%</b>	<b>9.8%</b>
7	LGR	E	87.0	8.6	748.2	0.4	0.7	15.7%	10.9%
<b>Total</b>			<b>87.0</b>	<b>--</b>	<b>748.2</b>	<b>--</b>	<b>--</b>	<b>15.7%</b>	<b>10.9%</b>
<b>Grand Total</b>			<b>555.0</b>	<b>--</b>	<b>6841.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	90.0	21.0	1890.0	0.7	1.5	16.1%	25.7%
2	Pool	E	100.0	16.5	1650.0	1.4	2.3	17.9%	22.5%
3	Pool	E	120.0	11.0	1320.0	1.3	2.5	21.4%	18.0%
<b>Total</b>			<b>310.0</b>	<b>--</b>	<b>4860.0</b>	<b>--</b>	<b>--</b>	<b>55.4%</b>	<b>66.2%</b>
<b>Average</b>			<b>103.3</b>	<b>16.2</b>	<b>1620.0</b>	<b>1.1</b>	<b>2.1</b>	<b>--</b>	<b>--</b>
4	Run	E	60.0	8.0	480.0	0.4	0.8	10.7%	6.5%
5	Run	E	45.0	17.0	765.0	0.2	0.7	8.0%	10.4%
<b>Total</b>			<b>105.0</b>	<b>--</b>	<b>1245.0</b>	<b>--</b>	<b>--</b>	<b>18.8%</b>	<b>16.9%</b>
<b>Average</b>			<b>52.5</b>	<b>12.5</b>	<b>622.5</b>	<b>0.3</b>	<b>0.8</b>	<b>--</b>	<b>--</b>
6	HGR	E	55.0	8.5	467.5	0.3	0.7	9.8%	6.4%
<b>Total</b>			<b>55.0</b>	<b>--</b>	<b>467.5</b>	<b>--</b>	<b>--</b>	<b>9.8%</b>	<b>6.4%</b>
7	LGR	E	90.0	8.6	774.0	0.4	0.7	16.1%	10.5%
<b>Total</b>			<b>90.0</b>	<b>--</b>	<b>774.0</b>	<b>--</b>	<b>--</b>	<b>16.1%</b>	<b>10.5%</b>
<b>Grand Total</b>			<b>560.0</b>	<b>--</b>	<b>7346.5</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

# South Fork Long Canyon Creek

## SFLC2.3 (Bypass Reach)

### 2009 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	89.0	17.0	1513.0	1.4	2.4	15.8%	20.3%
2	Pool	E	90.0	17.5	1575.0	0.7	2.3	16.0%	21.1%
3	Pool	E	105.0	13.0	1365.0	1.3	2.6	18.7%	18.3%
<b>Total</b>			<b>284.0</b>		<b>4453.0</b>			<b>50.5%</b>	<b>59.7%</b>
<b>Average</b>			<b>94.7</b>	<b>15.8</b>	<b>1484.3</b>	<b>1.1</b>	<b>2.4</b>		
4	Run	E	60.0	8.0	480.0	0.4	0.8	10.7%	6.4%
5	Run	E	40.0	14.2	568.0	0.3	0.7	7.1%	7.6%
<b>Total</b>			<b>100.0</b>		<b>1048.0</b>			<b>17.8%</b>	<b>14.1%</b>
<b>Average</b>			<b>50.0</b>	<b>11.1</b>	<b>524.0</b>	<b>0.4</b>	<b>0.8</b>		
6	HGR	E	72.0	8.0	576.0	0.2	0.6	12.8%	7.7%
<b>Total</b>			<b>72.0</b>		<b>576.0</b>			<b>12.8%</b>	<b>7.7%</b>
7	LGR	E	106.0	13.0	1378.0	0.3	0.7	18.9%	18.5%
<b>Total</b>			<b>106.0</b>		<b>1378.0</b>			<b>18.9%</b>	<b>18.5%</b>
<b>Grand Total</b>			<b>562.0</b>		<b>7455.0</b>			<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle  
<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# South Fork Long Canyon Creek

SFLC3.0 (Bypass Reach)

## 2009 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	85.0	18.0	1530.0	1.4	2.8	16.8%	21.6%
2	Pool	E	90.0	19.0	1710.0	1.5	3.0	17.8%	24.1%
3	Pool	E	80.0	14.0	1120.0	1.2	2.3	15.8%	15.8%
<b>Total</b>			<b>255.0</b>		<b>4360.0</b>			<b>50.5%</b>	<b>61.5%</b>
<b>Average</b>			<b>85.0</b>	<b>17.0</b>	<b>1453.3</b>	<b>1.4</b>	<b>2.7</b>		
4	Run	E	55.0	7.0	385.0	0.3	1.2	10.9%	5.4%
5	Run	E	45.0	10.0	450.0	0.3	0.6	8.9%	6.4%
<b>Total</b>			<b>100.0</b>		<b>835.0</b>			<b>19.8%</b>	<b>11.8%</b>
<b>Average</b>			<b>50.0</b>	<b>8.5</b>	<b>417.5</b>	<b>0.3</b>	<b>0.9</b>		
6	HGR	E	60.0	12.0	720.0	0.3	0.7	11.9%	10.2%
<b>Total</b>			<b>60.0</b>		<b>720.0</b>			<b>11.9%</b>	<b>10.2%</b>
7	LGR	E	90.0	13.0	1170.0	0.3	0.6	17.8%	16.5%
<b>Total</b>			<b>90.0</b>		<b>1170.0</b>			<b>17.8%</b>	<b>16.5%</b>
<b>Grand Total</b>			<b>505.0</b>		<b>7085.0</b>			<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# South Fork Long Canyon Creek

SFLC4.2 (Comparison Reach above South Fork Long Canyon Diversion)

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	112.0	13.0	1456.0	1.7	3.4	23.1%	28.3%
2	Pool	E	63.0	12.5	787.5	1.3	2.8	13.0%	15.3%
3	Pool	E	60.0	13.5	810.0	0.7	2.1	12.4%	15.8%
<b>Total</b>			<b>235.0</b>	<b>--</b>	<b>3053.5</b>	<b>--</b>	<b>--</b>	<b>48.5%</b>	<b>59.4%</b>
<b>Average</b>			<b>78.3</b>	<b>13.0</b>	<b>1017.8</b>	<b>1.2</b>	<b>2.8</b>	<b>--</b>	<b>--</b>
4	Run	E	55.0	7.0	385.0	0.4	0.9	11.3%	7.5%
5	Run	E	47.0	8.5	399.5	0.5	1.0	9.7%	7.8%
<b>Total</b>			<b>102.0</b>	<b>--</b>	<b>784.5</b>	<b>--</b>	<b>--</b>	<b>21.0%</b>	<b>15.3%</b>
<b>Average</b>			<b>51.0</b>	<b>7.8</b>	<b>392.3</b>	<b>0.5</b>	<b>1.0</b>	<b>--</b>	<b>--</b>
6	HGR	E	59.0	7.0	413.0	0.3	0.9	12.2%	8.0%
<b>Total</b>			<b>59.0</b>	<b>--</b>	<b>413.0</b>	<b>--</b>	<b>--</b>	<b>12.2%</b>	<b>8.0%</b>
7	LGR	E	89.0	10.0	890.0	0.3	0.6	18.4%	17.3%
<b>Total</b>			<b>89.0</b>	<b>--</b>	<b>890.0</b>	<b>--</b>	<b>--</b>	<b>18.4%</b>	<b>17.3%</b>
<b>Grand Total</b>			<b>485.0</b>	<b>--</b>	<b>5141.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	112.0	11.2	1254.4	1.4	2.9	23.5%	25.5%
2	Pool	E	63.0	13.0	819.0	1.2	3.4	13.2%	16.7%
3	Pool	E	60.0	14.0	840.0	1.3	3.4	12.6%	17.1%
<b>Total</b>			<b>235.0</b>	<b>--</b>	<b>2913.4</b>	<b>--</b>	<b>--</b>	<b>49.4%</b>	<b>59.3%</b>
<b>Average</b>			<b>78.3</b>	<b>12.7</b>	<b>971.1</b>	<b>1.3</b>	<b>3.2</b>	<b>--</b>	<b>--</b>
4	Run	E	50.0	7.0	350.0	0.4	0.9	10.5%	7.1%
5	Run	E	42.0	4.5	189.0	0.4	0.7	8.8%	3.8%
<b>Total</b>			<b>92.0</b>	<b>--</b>	<b>539.0</b>	<b>--</b>	<b>--</b>	<b>19.3%</b>	<b>11.0%</b>
<b>Average</b>			<b>46.0</b>	<b>5.8</b>	<b>269.5</b>	<b>0.4</b>	<b>0.8</b>	<b>--</b>	<b>--</b>
6	HGR	E	60.0	6.5	390.0	0.3	0.7	12.6%	7.9%
<b>Total</b>			<b>60.0</b>	<b>--</b>	<b>390.0</b>	<b>--</b>	<b>--</b>	<b>12.6%</b>	<b>7.9%</b>
7	LGR	E	89.0	12.0	1068.0	0.3	0.9	18.7%	21.7%
<b>Total</b>			<b>89.0</b>	<b>--</b>	<b>1068.0</b>	<b>--</b>	<b>--</b>	<b>18.7%</b>	<b>21.7%</b>
<b>Grand Total</b>			<b>476.0</b>	<b>--</b>	<b>4910.4</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

# South Fork Long Canyon Creek

## SFLC4.2 (Comparison Reach above South Fork Long Canyon Diversion)

### 2009 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	100.0	14.0	1400.0	1.4	3.1	20.9%	24.1%
2	Pool	E	62.0	11.0	682.0	1.1	2.5	13.0%	11.7%
3	Pool	E	60.0	13.0	780.0	1.2	3.2	12.6%	13.4%
<b>Total</b>			<b>222.0</b>		<b>2862.0</b>			<b>46.4%</b>	<b>49.2%</b>
<b>Average</b>			<b>74.0</b>	<b>12.7</b>	<b>954.0</b>	<b>1.2</b>	<b>2.9</b>		
4	Run	E	61.0	16.0	976.0	0.4	0.8	12.8%	16.8%
5	Run	E	45.0	10.0	450.0	0.4	1.1	9.4%	7.7%
<b>Total</b>			<b>106.0</b>		<b>1426.0</b>			<b>22.2%</b>	<b>24.5%</b>
<b>Average</b>			<b>53.0</b>	<b>13.0</b>	<b>713.0</b>	<b>0.4</b>	<b>1.0</b>		
6	HGR	E	60.0	4.5	270.0	0.3	1.3	12.6%	4.6%
<b>Total</b>			<b>60.0</b>		<b>270.0</b>			<b>12.6%</b>	<b>4.6%</b>
7	LGR	E	90.0	14.0	1260.0	0.3	0.7	18.8%	21.7%
<b>Total</b>			<b>90.0</b>		<b>1260.0</b>			<b>18.8%</b>	<b>21.7%</b>
<b>Grand Total</b>			<b>478.0</b>		<b>5818.0</b>			<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# South Fork Long Canyon Creek

## SFLC5.2 (Comparison Reach above South Fork Long Canyon Diversion)

### 2009 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	61.0	12.0	732.0	0.7	1.3	14.0%	16.8%
2	Pool	E	60.0	14.0	840.0	0.8	2.5	13.8%	19.3%
3	Pool	E	60.0	11.0	660.0	1.0	2.0	13.8%	15.2%
<b>Total</b>			<b>181.0</b>		<b>2232.0</b>			<b>41.6%</b>	<b>51.3%</b>
<b>Average</b>			<b>60.3</b>	<b>12.3</b>	<b>744.0</b>	<b>0.8</b>	<b>1.9</b>		
4	Run	E	51.0	10.0	510.0	0.4	1.0	11.7%	11.7%
5	Run	E	48.0	11.5	552.0	0.3	0.6	11.0%	12.7%
<b>Total</b>			<b>99.0</b>		<b>1062.0</b>			<b>22.8%</b>	<b>24.4%</b>
<b>Average</b>			<b>49.5</b>	<b>10.8</b>	<b>531.0</b>	<b>0.4</b>	<b>0.8</b>		
6	HGR	E	65.0	8.0	520.0	0.4	1.2	14.9%	11.9%
<b>Total</b>			<b>65.0</b>		<b>520.0</b>			<b>14.9%</b>	<b>11.9%</b>
7	LGR	E	90.0	6.0	540.0	0.2	0.5	20.7%	12.4%
<b>Total</b>			<b>90.0</b>		<b>540.0</b>			<b>20.7%</b>	<b>12.4%</b>
<b>Grand Total</b>			<b>435.0</b>		<b>4354.0</b>			<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

**Duncan Creek**  
D6.3 (Bypass Reach)

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	76.0	17.1	1299.6	0.8	2.0	17.04%	14.50%
2	Pool	E	96.0	25.5	2448.0	1.4	2.1	21.52%	27.31%
3	Pool	E	66.0	33.0	2178.0	1.7	3.0	14.80%	24.30%
<b>Total</b>			<b>238.0</b>	<b>--</b>	<b>5925.6</b>	<b>--</b>	<b>--</b>	<b>53.36%</b>	<b>66.11%</b>
<b>Average</b>			<b>111.0</b>	<b>45.0</b>	<b>10551.6</b>	<b>1.3</b>	<b>2.4</b>	<b>--</b>	<b>--</b>
4	Run	E	69.0	8.0	552.0	1.0	2.0	15.47%	6.16%
<b>Total</b>			<b>69.0</b>	<b>8.0</b>	<b>552.0</b>	<b>1.0</b>	<b>2.0</b>	<b>15.47%</b>	<b>6.16%</b>
5	HGR	E	100.0	19.0	1900.0	0.8	1.2	22.42%	21.20%
<b>Total</b>			<b>100.0</b>	<b>19.0</b>	<b>1900.0</b>	<b>0.8</b>	<b>1.2</b>	<b>22.42%</b>	<b>21.20%</b>
6	LGR	E	39.0	15.0	585.0	0.5	1.0	8.74%	6.53%
<b>Total</b>			<b>39.0</b>	<b>15.0</b>	<b>585.0</b>	<b>0.5</b>	<b>1.0</b>	<b>8.74%</b>	<b>6.53%</b>
<b>Grand Total</b>			<b>446.0</b>	<b>--</b>	<b>8962.6</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	76.0	17.1	1299.6	1.5	2.6	16.7%	13.6%
2	Pool	E	96.0	26.0	2496.0	1.0	2.4	21.1%	26.2%
3	Pool	E	66.0	33.0	2178.0	3.0	3.9	14.5%	22.9%
<b>Total</b>			<b>238.0</b>	<b>--</b>	<b>5973.6</b>	<b>--</b>	<b>--</b>	<b>52.2%</b>	<b>62.7%</b>
<b>Average</b>			<b>79.3</b>	<b>25.4</b>	<b>1991.2</b>	<b>1.8</b>	<b>3.0</b>		
4	Run	E	69.0	8.0	552.0	2.3	2.8	15.1%	5.8%
<b>Total</b>			<b>69.0</b>	<b>--</b>	<b>552.0</b>	<b>--</b>	<b>--</b>	<b>15.1%</b>	<b>5.8%</b>
5	HGR	E	110.0	22.0	2420.0	0.5	1.2	24.1%	25.4%
<b>Total</b>			<b>110.0</b>	<b>--</b>	<b>2420.0</b>	<b>--</b>	<b>--</b>	<b>24.1%</b>	<b>25.4%</b>
6	LGR	E	39.0	15.0	585.0	0.6	1.2	8.6%	6.1%
<b>Total</b>			<b>39.0</b>	<b>--</b>	<b>585.0</b>	<b>--</b>	<b>--</b>	<b>8.6%</b>	<b>6.1%</b>
<b>Grand Total</b>			<b>456.0</b>	<b>--</b>	<b>9530.6</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

**Duncan Creek**  
D6.3 (Bypass Reach)

Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# Duncan Creek

## D8.3 (Bypass Reach)

### 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	61.5	18.0	1107.0	1.7	2.6	14.0%	15.1%
2	Pool	E	68.0	16.0	1088.0	2.4	4.0	15.5%	14.8%
3	Pool	E	103.0	22.0	2266.0	1.2	4.0	23.5%	30.9%
<b>Total</b>			<b>232.5</b>	<b>--</b>	<b>4461.0</b>	<b>--</b>	<b>--</b>	<b>53.0%</b>	<b>60.7%</b>
<b>Average</b>			<b>77.5</b>	<b>18.7</b>	<b>1487.0</b>	<b>1.8</b>	<b>3.5</b>		
4	Run	E	60.0	12.5	750.0	0.7	1.2	13.7%	10.2%
<b>Total</b>			<b>60.0</b>	<b>--</b>	<b>750.0</b>	<b>--</b>	<b>--</b>	<b>13.7%</b>	<b>10.2%</b>
5	HGR	E	89.0	15.0	1335.0	0.5	11.5	20.3%	18.2%
<b>Total</b>			<b>89.0</b>	<b>--</b>	<b>1335.0</b>	<b>--</b>	<b>--</b>	<b>20.3%</b>	<b>18.2%</b>
6	LGR	E	57.0	14.0	798.0	0.8	1.6	13.0%	10.9%
<b>Total</b>			<b>57.0</b>	<b>--</b>	<b>798.0</b>	<b>--</b>	<b>--</b>	<b>13.0%</b>	<b>10.9%</b>
<b>Grand Total</b>			<b>438.5</b>	<b>--</b>	<b>7344.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

## Duncan Creek

### D9.0 (Comparison Reach above Duncan Diversion)

#### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	87.0	24.5	2131.5	0.8	2.3	19.0%	22.0%
2	Pool	E	109.0	28.0	3052.0	1.2	3.1	23.9%	31.5%
3	Pool	E	60.0	20.0	1200.0	1.5	3.3	13.1%	12.4%
<b>Total</b>			<b>256.0</b>	<b>--</b>	<b>6383.5</b>	<b>--</b>	<b>--</b>	<b>56.0%</b>	<b>65.8%</b>
<b>Average</b>			<b>85.3</b>	<b>24.2</b>	<b>2127.8</b>	<b>1.2</b>	<b>2.9</b>	<b>--</b>	<b>--</b>
4	Run	E	60.0	15.0	900.0	0.8	1.4	13.1%	9.3%
<b>Total</b>			<b>60.0</b>	<b>--</b>	<b>900.0</b>	<b>--</b>	<b>--</b>	<b>13.1%</b>	<b>9.3%</b>
5	HGR	E	90.0	11.0	990.0	0.7	1.5	19.7%	10.2%
<b>Total</b>			<b>90.0</b>	<b>--</b>	<b>990.0</b>	<b>--</b>	<b>--</b>	<b>19.7%</b>	<b>10.2%</b>
6	LGR	E	51.0	28.0	1428.0	0.4	0.9	11.2%	14.7%
<b>Total</b>			<b>51.0</b>	<b>--</b>	<b>1428.0</b>	<b>--</b>	<b>--</b>	<b>11.2%</b>	<b>14.7%</b>
<b>Grand Total</b>			<b>457.0</b>	<b>--</b>	<b>9701.5</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

#### 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	85.0	25.0	2125.0	1.2	2.5	18.6%	24.2%
2	Pool	E	109.0	14.0	1526.0	1.8	3.2	23.8%	17.4%
3	Pool	E	60.0	19.0	1140.0	1.4	3.1	13.1%	13.0%
<b>Total</b>			<b>254.0</b>	<b>--</b>	<b>4791.0</b>	<b>--</b>	<b>--</b>	<b>55.5%</b>	<b>54.6%</b>
<b>Average</b>			<b>84.7</b>	<b>19.3</b>	<b>1597.0</b>	<b>1.5</b>	<b>2.9</b>		
4	Run	E	60.0	14.0	840.0	0.6	1.5	13.1%	9.6%
<b>Total</b>			<b>60.0</b>	<b>--</b>	<b>840.0</b>	<b>--</b>	<b>--</b>	<b>13.1%</b>	<b>9.6%</b>
5	HGR	E	92.0	15.0	1380.0	0.5	2.0	20.1%	15.7%
<b>Total</b>			<b>92.0</b>	<b>--</b>	<b>1380.0</b>	<b>--</b>	<b>--</b>	<b>20.1%</b>	<b>15.7%</b>
6	LGR	E	52.0	34.0	1768.0	0.5	1.0	11.4%	20.1%
<b>Total</b>			<b>52.0</b>	<b>--</b>	<b>1768.0</b>	<b>--</b>	<b>--</b>	<b>11.4%</b>	<b>20.1%</b>
<b>Grand Total</b>			<b>458.0</b>	<b>--</b>	<b>8779.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>E = Electrofishing

## Duncan Creek

D9.0 (Comparison Reach above Duncan Diversion)

Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

# Duncan Creek

## D10.0 (Comparison Reach above Duncan Diversion)

### 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	E	77.0	17.0	1309.0	1.1	2.4	17.3%	16.2%
2	Pool	E	40.0	60.0	2400.0	1.2	2.1	9.0%	29.6%
3	Pool	E	120.0	17.0	2040.0	2.9	3.8	26.9%	25.2%
<b>Total</b>			<b>237.0</b>	<b>--</b>	<b>5749.0</b>	<b>--</b>	<b>--</b>	<b>53.1%</b>	<b>71.0%</b>
<b>Average</b>			<b>79.0</b>	<b>31.3</b>	<b>1916.3</b>	<b>1.7</b>	<b>2.8</b>	<b>--</b>	<b>--</b>
4	Run	E	66.0	7.0	462.0	0.3	1.5	14.8%	5.7%
<b>Total</b>			<b>66.0</b>	<b>--</b>	<b>462.0</b>	<b>--</b>	<b>--</b>	<b>14.8%</b>	<b>5.7%</b>
5	HGR	E	91.0	11.0	1001.0	0.3	1.9	20.4%	12.4%
<b>Total</b>			<b>91.0</b>	<b>--</b>	<b>1001.0</b>	<b>--</b>	<b>--</b>	<b>20.4%</b>	<b>12.4%</b>
6	LGR	E	52.0	17.0	884.0	0.3	1.5	11.7%	10.9%
<b>Total</b>			<b>52.0</b>	<b>--</b>	<b>884.0</b>	<b>--</b>	<b>--</b>	<b>11.7%</b>	<b>10.9%</b>
<b>Grand Total</b>			<b>446.0</b>	<b>--</b>	<b>8096.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

### Photos of Representative Habitat Units:



POOL



RUN



HGR



LGR

## North Fork of the Middle Fork American River

### NFMF2.3 (Bypass Reach)

2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	145.0	33.0	4785.0	*	8.0	17.7%	14.1%
2	Pool	S	153.0	46.0	7038.0	*	8.5	18.7%	20.7%
3	Pool	S	162.0	37.0	5994.0	*	8.5	19.8%	17.6%
4	Pool	S	75.0	45.0	3375.0	*	3.5	9.2%	9.9%
<b>Total</b>			<b>535.0</b>	<b>--</b>	<b>21192.0</b>	<b>--</b>	<b>--</b>	<b>65.4%</b>	<b>62.4%</b>
<b>Average</b>			<b>133.8</b>	<b>40.3</b>	<b>5298.0</b>	<b>--</b>	<b>7.1</b>	<b>--</b>	<b>--</b>
5	Run	E	48.0	48.0	2304.0	1.4	3.0	5.9%	6.8%
6	Run	E	75.0	50.0	3750.0	1.1	2.6	9.2%	11.0%
<b>Total</b>			<b>123.0</b>	<b>--</b>	<b>6054.0</b>	<b>--</b>	<b>--</b>	<b>15.0%</b>	<b>17.8%</b>
<b>Average</b>			<b>61.5</b>	<b>49.0</b>	<b>3027.0</b>	<b>1.3</b>	<b>2.8</b>	<b>--</b>	<b>--</b>
7	HGR	E	160.0	42.0	6720.0	0.6	4.2	19.6%	19.8%
<b>Total</b>			<b>160.0</b>	<b>--</b>	<b>6720.0</b>	<b>--</b>	<b>--</b>	<b>19.6%</b>	<b>19.8%</b>
<b>Grand Total</b>			<b>818.0</b>	<b>--</b>	<b>33966.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	135.0	33.0	4455.0	*	8.0	15.6%	12.2%
2	Pool	S	165.0	46.0	7590.0	*	8.5	19.1%	20.7%
3	Pool	S	171.0	37.0	6327.0	*	8.5	19.8%	17.3%
4	Pool	S	90.0	45.0	4050.0	*	3.5	10.4%	11.1%
<b>Total</b>			<b>561.0</b>	<b>--</b>	<b>22422.0</b>	<b>--</b>	<b>--</b>	<b>64.9%</b>	<b>61.2%</b>
<b>Average</b>			<b>140.3</b>	<b>40.3</b>	<b>5605.5</b>	<b>--</b>	<b>7.1</b>	<b>--</b>	<b>--</b>
5	Run	E	53.0	45.0	2385.0	0.3	2.7	6.1%	6.5%
6	Run	E	90.0	48.0	4320.0	1.2	2.2	10.4%	11.8%
<b>Total</b>			<b>143.0</b>	<b>--</b>	<b>6705.0</b>	<b>--</b>	<b>--</b>	<b>16.6%</b>	<b>18.3%</b>
<b>Average</b>			<b>71.5</b>	<b>46.5</b>	<b>3352.5</b>	<b>0.8</b>	<b>2.5</b>	<b>--</b>	<b>--</b>
7	HGR	E	160.0	47.0	7520.0	1.0	2.2	18.5%	20.5%
<b>Total</b>			<b>160.0</b>	<b>--</b>	<b>7520.0</b>	<b>--</b>	<b>--</b>	<b>18.5%</b>	<b>20.5%</b>
<b>Grand Total</b>			<b>864.0</b>	<b>--</b>	<b>36647.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

**North Fork of the Middle Fork American River**  
NFMF2.3 (Bypass Reach)

Photos of Representative Habitat Units:



POOL



RUN



HGR

# North Fork American River

## NF18.4 (Bypass Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	480.0	12.0	5760.0	3.5	6.0	10.9%	1.2%
2	Pool	S	585.0	270.0	157950.0	7.0	14.0	13.3%	32.9%
3	Pool	S	309.0	75.0	23175.0	4.0	7.0	7.0%	4.8%
4	Pool	S	345.0	96.0	33120.0	2.8	4.5	7.9%	6.9%
5	Pool	S	750.0	50.0	37500.0	5.5	18.0	17.1%	7.8%
<b>Total</b>			<b>2469.0</b>	<b>--</b>	<b>257505.0</b>	<b>--</b>	<b>--</b>	<b>56.2%</b>	<b>53.6%</b>
<b>Average</b>			<b>493.8</b>	<b>100.6</b>	<b>51501.0</b>	<b>4.6</b>	<b>9.9</b>	<b>--</b>	<b>--</b>
6	Run	S	504.0	186.0	93744.0	2.5	8.0	11.5%	19.5%
7	Run	S	216.0	55.0	11880.0	1.8	3.6	4.9%	2.5%
8	Run	S	1205.0	97.0	116885.0	1.2	3.1	27.4%	24.4%
<b>Total</b>			<b>1925.0</b>	<b>--</b>	<b>222509.0</b>	<b>--</b>	<b>--</b>	<b>43.8%</b>	<b>46.4%</b>
<b>Average</b>			<b>641.7</b>	<b>112.7</b>	<b>74169.7</b>	<b>1.8</b>	<b>4.9</b>	<b>--</b>	<b>--</b>
<b>Grand Total</b>			<b>4394.0</b>	<b>--</b>	<b>480014.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling

### Photos of Representative Habitat Units:



POOL



RUN

# North Fork American River

## NF31.3 (Comparison Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	630.0	90.0	56700.0	2.0	5.0	19.7%	19.2%
2	Pool	S	537.0	111.0	59607.0	2.0	6.5	16.8%	20.1%
3	Pool	S	1032.0	108.0	111456.0	4.0	11.0	32.3%	37.7%
<b>Total</b>			<b>2199.0</b>	<b>--</b>	<b>227763.0</b>	<b>--</b>	<b>--</b>	<b>68.8%</b>	<b>77.0%</b>
<b>Average</b>			<b>733.0</b>	<b>103.0</b>	<b>75921.0</b>	<b>2.7</b>	<b>7.5</b>	<b>--</b>	<b>--</b>
4	Run	S	117.0	36.0	4212.0	1.0	2.0	3.7%	1.4%
5	Run	S	237.0	102.0	24174.0	1.0	2.0	7.4%	8.2%
6	Run	S	195.0	66.0	12870.0	0.6	1.2	6.1%	4.4%
7	Run	S	447.0	60.0	26820.0	0.6	2.1	14.0%	9.1%
<b>Total</b>			<b>996.0</b>	<b>--</b>	<b>68076.0</b>	<b>--</b>	<b>--</b>	<b>31.2%</b>	<b>23.0%</b>
<b>Average</b>			<b>249.0</b>	<b>66.0</b>	<b>17019.0</b>	<b>0.8</b>	<b>1.8</b>	<b>--</b>	<b>--</b>
<b>Grand Total</b>			<b>3195.0</b>	<b>--</b>	<b>295839.0</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling

### Photos of Representative Habitat Units:



POOL



RUN

# North Fork American River

## NF53.7 (Comparison Reach)

### 2007 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	573.0	93.0	53289.0	6.0	16.0	31.4%	44.4%
2	Pool	S	405.0	72.0	29160.0	5.5	14.0	22.2%	24.3%
3	Pool	S	85.5	18.0	1539.0	2.0	4.0	4.7%	1.3%
4	Pool	S	429.0	61.5	26383.5	6.0	16.0	23.5%	22.0%
<b>Total</b>			<b>1492.5</b>	<b>--</b>	<b>110371.5</b>	<b>--</b>	<b>--</b>	<b>81.9%</b>	<b>91.9%</b>
<b>Average</b>			<b>373.1</b>	<b>61.1</b>	<b>27592.9</b>	<b>--</b>	<b>12.5</b>	<b>--</b>	<b>--</b>
5	Run	E	189.0	39.0	7371.0	1.2	2.0	10.4%	6.1%
6	Run	S	93.0	17.0	1581.0	1.2	2.0	5.1%	1.3%
<b>Total</b>			<b>282.0</b>	<b>--</b>	<b>8952.0</b>	<b>--</b>	<b>--</b>	<b>15.5%</b>	<b>7.5%</b>
<b>Average</b>			<b>141.0</b>	<b>28.0</b>	<b>4476.0</b>	<b>1.2</b>	<b>2.0</b>	<b>--</b>	<b>--</b>
7	HGR	S	48.0	15.0	720.0	1.3	1.7	2.6%	0.6%
<b>Total</b>			<b>48.0</b>	<b>--</b>	<b>720.0</b>	<b>--</b>	<b>--</b>	<b>2.6%</b>	<b>0.6%</b>
<b>Grand Total</b>			<b>1822.5</b>	<b>--</b>	<b>120043.5</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

### 2008 Sampled Mesohabitat Units

Unit Number	Unit Type <sup>1</sup>	Sampling Method <sup>2</sup>	Length (ft)	Width (ft)	Unit Area (ft <sup>2</sup> )	Mean Depth (ft)	Max Depth (ft)	% of Total Survey Length	% of Total Survey Area
1	Pool	S	573.0	93.0	53289.0	6.0	16.0	31.4%	43.8%
2	Pool	S	405.0	72.0	29160.0	5.5	14.0	22.2%	24.0%
3	Pool	S	85.5	18.0	1539.0	2.0	4.0	4.7%	1.3%
4	Pool	S	429.0	61.5	26383.5	6.0	16.0	23.5%	21.7%
<b>Total</b>			<b>1492.5</b>	<b>--</b>	<b>110371.5</b>	<b>--</b>	<b>--</b>	<b>81.9%</b>	<b>90.7%</b>
<b>Average</b>			<b>373.1</b>	<b>61.1</b>	<b>27592.9</b>	<b>4.9</b>	<b>12.5</b>	<b>--</b>	<b>--</b>
5	Run	E	189.0	48.0	9072.0	1.6	2.7	10.4%	7.5%
6	Run	S	93.0	17.0	1581.0	1.2	2.2	5.1%	1.3%
<b>Total</b>			<b>282.0</b>	<b>--</b>	<b>10653.0</b>	<b>--</b>	<b>--</b>	<b>15.5%</b>	<b>8.8%</b>
<b>Average</b>			<b>141.0</b>	<b>32.5</b>	<b>5326.5</b>	<b>1.4</b>	<b>2.5</b>	<b>--</b>	<b>--</b>
7	HGR	S	48.0	15.0	720.0	1.3	0.7	2.6%	0.6%
<b>Total</b>			<b>48.0</b>	<b>--</b>	<b>720.0</b>	<b>--</b>	<b>--</b>	<b>2.6%</b>	<b>0.6%</b>
<b>Grand Total</b>			<b>1822.5</b>	<b>--</b>	<b>121744.5</b>	<b>--</b>	<b>--</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>LGR = Low Gradient Riffle; HGR = High Gradient Riffle

<sup>2</sup>S = Snorkeling; E = Electrofishing

**North Fork American River**  
NF53.7 (Comparison Reach)

Photos of Representative Habitat Units:



POOL



RUN



HGR

## Representative Photos of Project - Reservoirs and Diversion Pools

### Ralston Afterbay



### Middle Fork Interbay



French Meadows Reservoir



Hell Hole Reservoir



North Fork Long Canyon Creek Diversion Pool



South Fork Long Canyon Creek Diversion Pool



Duncan Creek Diversion Pool



## **TABLES**

**Table A-1. Reach Mesohabitat Percentages.**

Study River and Site ID	Rosgen Geomorphic Reach <sup>1</sup> (Type, Name)	Reachwide Mesohabitat Percentages by Length				Total
		Pool	Run	High Gradient Riffle	Low Gradient Riffle	
<b>Middle Fork American River Downstream of Ralston Afterbay</b>						
MF4.8	F, MFAR-R1	59.5%	30.0%	2.7%	7.9%	100.0%
MF14.1	F, MFAR-R3	55.2%	29.2%	4.6%	11.0%	100.0%
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>						
MF26.2	Bc/F, MFAR-R4	43.3%	28.6%	21.2%	6.9%	100.0%
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>						
MF36.2	Ba/Fb, MFAR-R5	60.3%	16.6%	18.0%	5.1%	100.0%
MF44.7	Ba/Fb, MFAR-R5	60.3%	16.6%	18.0%	5.1%	100.0%
MF51.8	B3	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
<b>Rubicon River</b>						
R3.5	Bc/F, RUB-R1	49.0%	27.7%	11.6%	11.7%	100.0%
R20.9	B/Fb, RUB-R2	46.2%	24.7%	25.2%	3.9%	100.0%
R25.7	C, RUB-R3	43.4%	24.9%	13.2%	18.5%	100.0%
R36.2	B3	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
<b>Long Canyon Creek</b>						
LC9.0	F, LONG-R2	43.6%	16.2%	13.6%	26.7%	100.0%
<b>North Fork Long Canyon Creek</b>						
NFLC1.9	B, NFLONG-R1	43.0%	15.1%	24.2%	17.7%	100.0%
NFLC3.8	B2-3	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
<b>South Fork Long Canyon Creek</b>						
SFLC2.3	B, SFLONG-R1	40.3%	27.7%	15.2%	16.8%	100.0%
SFLC4.2	B3	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
<b>Duncan Creek</b>						
D6.3	B/F, DUN-R2	52.8%	14.3%	25.2%	7.7%	100.0%
D9.0	B1-2	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
<b>North Fork of the Middle Fork American River</b>						
NFMF2.3	F2-3/B2-3	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
<b>North Fork American River</b>						
NF18.4	F	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
NF31.3	F3-4	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>
NF53.7	unknown	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>

<sup>1</sup>For Location of Geomorphic Reaches see Map AQ 2-1. Geomorphic reaches are identified in: Placer County Water Agency (PCWA). 2007. 2006 Physical Habitat Characterization Study Report. In PCWA's Pre-Application Document (PAD) for the Middle Fork American River Project (FERC Project No. 2079), 2005/2006 Technical Study Plans and Reports, SD G (1 of 2).

<sup>2</sup>NA = Habitat percentages are unavailable for sites outside of the Project Study area.

**Table A-2. August 2007 Water Temperature Summary.**

Study Site	Water Temperature (°F) <sup>1</sup>		
	Avg	Max	Min
<b>Middle Fork American River Downstream of Ralston Afterbay</b>			
MF4.8	61.8	67.3	57.7
MF14.1	57.8	61.1	54.4
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>			
MF26.2	67.5	72.7	62.4
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>			
MF36.2	64.9	70.3	59.8
MF44.7	56.5	60.5	51.8
MF51.8	63.3	73.8	51.9
<b>Rubicon River</b>			
R3.5	71.1	77.2	66.1
R20.9	60.8	64.7	57.0
R25.7	55.7	60.1	51.3
R36.2	66.1	72.0	59.8
<b>Long Canyon Creek</b>			
LC9.0	60.5	67.8	54.6
<b>North Fork Long Canyon Creek</b>			
NFLC1.9	60.9	74.2	52.9
NFLC3.8	58.7	62.4	54.8
<b>South Fork Long Canyon Creek</b>			
SFLC2.3	58.1	65.6	51.7
SFLC4.2	55.3	64.0	48.2
<b>Duncan Creek</b>			
D6.3	66.2	73.2	62.3
D9.0	63.5	68.8	60.4
<b>North Fork of the Middle Fork American River</b>			
NFMF2.3	70.0	76.4	64.4
<b>North Fork American River</b>			
NF18.4	64.2	69.6	60.4
NF31.3	74.7	82.7	68.8
NF53.7	-- <sup>2</sup>	--	--

<sup>1</sup> See 2006 Water Temperature Study Report (PCWA 2007c) for details and location of temperature probes

<sup>2</sup> Temperature data was not available for site NF53.7

**Table A-3a. 2007 Physical Habitat Characteristics of Potential Comparison Sampling Sites.**

Study Sites	Description	Rosgen Channel Type <sup>1</sup>	Elevation (ft)	Total Length (ft)	Total Area (acres)	Number of units sampled	Slope	Pool					Run					High Gradient Riffle				Low Gradient Riffle							
								Number sampled	Total Length	Percent of total length	Total Area	Percent of total area	Average max depth	Number sampled	Total Length	Percent of total length	Total Area	Percent of total area	Average max depth	Number sampled	Total Length	Percent of total length	Total Area	Percent of total area	Number sampled	Total Length	Percent of total length	Total Area	Percent of total area
MF44.7	MFAR below French Meadows	Ba/Fb	4505	710	0.598	6	4.5%	3	488	69	0.435	73	4.2	1	92	13	0.065	11	3.5	2	130	18	0.097	16	0	--	--	--	--
MF51.8	MFAR above French Meadows	B3	5295	660	0.655	6	1.0%	3	353	54	0.329	50	2.7	2	187	28	0.180	28	1.5	0	--	--	--	--	1	120	18	0.146	22
R25.7	Rubicon below Hell Hole	C	3927	413	0.790	7	1.3%	3	145	35	0.555	70	6.5	2	144	35	0.121	15	2.8	1	62	15	0.056	7	1	62	15	0.058	7
R36.2	Rubicon above Hell Hole	B3	4800	688	0.440	6	2.7%	3	502	73	0.362	83	4.0	2	122	18	0.024	6	0.8	1	64	9	0.053	12	0	--	--	--	--
NFLC1.9	North Fork Long Canyon below diversion	B	4462	399	0.121	7	3.5%	3	147	37	0.046	38	1.8	1	78	20	0.025	21	1.0	1	78	20	0.021	18	2	96	24	0.028	23
NFLC3.8	North Fork Long Canyon above diversion	B2-3	4859	431	0.116	7	6.6%	3	203	47	0.056	49	1.5	1	60	14	0.019	17	1.2	2	102	24	0.027	23	1	66	15	0.014	12
SFLC2.3	South Fork Long Canyon below diversion	B	4514	555	0.157	7	1.7%	3	287	52	0.091	58	2.3	2	116	21	0.034	21	0.8	1	65	12	0.015	10	1	87	16	0.017	11
SFLC4.2	South Fork Long Canyon above diversion	B3	4820	485	0.118	7	2.5%	3	235	49	0.070	59	2.8	2	102	21	0.018	15	1.0	1	59	12	0.009	8	1	89	18	0.020	17
D6.3	Duncan below diversion	B/F	4787	446	0.206	6	4.4%	3	238	53	0.136	66	2.4	1	69	15	0.013	6	2.0	1	100	22	0.044	21	1	39	9	0.013	7
D9.0	Duncan above diversion	B1-2	5338	457	0.223	6	4.5%	3	256	56	0.147	66	2.9	1	60	13	0.021	9	1.4	1	90	20	0.023	10	1	51	11	0.033	15
MF4.8	MFAR above Mammoth Bar	F	643	2460	7.798	9	0.3%	5	2460	64	7.798	78	14.0	4	1417	37	2.258	23	2.8	0	--	--	--	--	0	--	--	--	--
MF14.1	MFAR at Otter Creek	F	797	3374	8.328	7	0.3%	4	2157	64	5.544	67	9.4	2	1084	32	2.593	31	2.5	0	--	--	--	--	1	133	4	0.192	2
NF18.4	NFAR below MFAR Confluence	F	509	4394	11.019	5	0.6%	4	2469	56	5.912	54	9.9	3	1925	44	5.108	46	4.9	0	--	--	--	--	0	--	--	--	--
NF31.3	NFAR at Ponderosa Bridge	F3-4	781	3195	6.791	7	0.5%	3	2199	69	5.229	77	7.5	4	996	31	1.563	23	1.8	0	--	--	--	--	0	--	--	--	--
MF26.2	MFAR above Ralston	Ba/Fb	1188	971	1.038	8	2.9%	4	669	69	0.749	72	7.5	2	153	16	0.133	13	2.6	1	99	10	0.102	10	1	50	5	0.054	5
NFMF2.3	North Fork MFAR at Circle Bridge	F2-3/B2-3	1263	818	0.780	7	2.1%	4	535	65	0.487	62	7.1	2	123	15	0.139	18	2.8	1	160	20	0.154	20	0	--	--	--	--
R3.5	Rubicon at Long Canyon	Bc/f	1325	1427	1.989	8	1.6%	4	1043	73	1.397	70	10.2	2	228	16	0.366	18	3.2	1	81	6	0.117	6	1	75	5	0.108	6
R20.9	Rubicon at Ellicott Bridge	B/Fb	3350	1224	1.687	7	1.6%	4	855	70	1.308	78	10.0	2	258	21	0.285	17	3.4	1	111	9	0.094	6	0	--	--	--	--
NF53.7	Upper NFAR	NA	1824	1823	2.756	7	0.7%	4	1493	82	2.534	92	12.5	2	282	16	0.206	8	2.0	1	48	3	0.017	1	0	--	--	--	--

**Table A-3b. 2008 Physical Habitat Characteristics of Potential Comparison Sampling Sites.**

Study Sites	Description	Rosgen Channel Type <sup>1</sup>	Elevation (ft)	Total Length (ft)	Total Area (acres)	Number of units sampled	Slope	Pool					Run					High Gradient Riffle				Low Gradient Riffle							
								Number sampled	Total Length	Percent of total length	Total Area	Percent of total area	Average max depth	Number sampled	Total Length	Percent of total length	Total Area	Percent of total area	Average max depth	Number sampled	Total Length	Percent of total length	Total Area	Percent of total area	Number sampled	Total Length	Percent of total length	Total Area	Percent of total area
SFLC2.3	South Fork Long Canyon below diversion	B	4514	560	0.169	7	1.7%	3	310	55	0.112	66	2.1	2	105	19	0.029	17	0.8	1	55	10	0.011	6	1	90	16	0.018	11
SFLC4.2	South Fork Long Canyon above diversion	B3	4820	476	0.113	7	2.5%	3	235	49	0.067	59	3.2	2	92	19	0.012	11	0.8	1	60	13	0.009	8	1	89	19	0.025	22
D6.3	Duncan below diversion	B/F	4787	456	0.219	6	4.4%	3	238	52	0.137	63	3.0	1	69	15	0.013	6	2.8	1	110	24	0.056	25	1	39	9	0.013	6
D8.3		B/F	5200	439	0.169	6	3.5%	3	233	53	0.102	61	3.5	1	60	14	0.017	10	1.2	1	89	20	0.031	18	1	57	13	0.018	11
D9.0		B1-2	5338	458	0.202	6	4.5%	3	254	56	0.110	55	2.9	1	60	13	0.019	13	1.5	1	92	20	0.032	16	1	52	11	0.041	20
D10.0	Duncan above diversion	B3	5500	446	0.186	6	4.7%	3	237	53	0.132	71	2.8	1	66	15	0.011	6	1.5	1	91	20	0.023	12	1	52	12	0.020	11
MF4.8	MFAR above Mammoth Bar	F	643	2460	7.798	9	0.3%	5	2460	64	7.798	78	14.0	4	1417	37	2.258	23	2.8	0	--	--	--	--	0	--	--	--	--
MF14.1	MFAR at Otter Creek	F	797	3374	8.328	7	0.3%	4	2157	64	5.544	67	9.4	2	1084	32	2.593	31	2.5	0	--	--	--	--	1	133	4	0.192	2
MF23.5	MFAR at Horseshoe Bar	F	1066	3531	6.470	10	0.3%	4	2082	70	4.870	75	13.0	3	576	19	0.873	14	4.5	1	114	4	0.185	3	2	231	8	0.542	8
MF26.2	MFAR above Ralston	Ba/Fb	1188	980	1.036	8	2.9%	4	669	68	0.749	72	7.5	2	161	16	0.154	15	2.4	1	99	10	0.084	8	1	51	5	0.049	5
NFMF2.3	North Fork MFAR at Circle Bridge	F2-3/B2-3	1263	864	0.841	7	2.1%	4	561	65	0.515	61	7.1	2	143	17	0.154	18	2.5	1	160	19	0.173	21	0	--	--	--	--
R20.9	Rubicon at Ellicott Bridge	B/Fb	3350	1240	1.714	7	1.6%	4	855	69	1.307	76	10.0	2	274	22	0.283	17	3.2	1	111	9	0.122	7	0	--	--	--	--
NF53.7	Upper NFAR	NA	1824	1823	2.795	7	0.7%	4	1493	82	2.534	90	12.5	2	282	16	0.245	9	2.5	1	48	3	0.017	1	0	--	--	--	--

<sup>1</sup> Peaking and bypass reach sites are channel typed to Level 1. Comparison sites are channel types to Level 1.

**Table A-3c. 2009 Physical Habitat Characteristics of Potential Comparison Sampling Sites.**

Study Sites	Description	Rosgen Channel Type <sup>1</sup>	Elevation (ft)	Total Length (ft)	Total Area (acres)	Number of Units Sampled	Slope	Pool					Run					High Gradient Riffle				Low Gradient Riffle							
								Number Sampled	Total Length	Percent of Total Length	Total Area	Percent of Total Area	Average Max Depth	Number Sampled	Total Length	Percent of Total Length	Total Area	Percent of Total Area	Average Max Depth	Number Sampled	Total Length	Percent of Total Length	Total area	Percent of Total Area	Number Sampled	Total Length	Percent of Total Length	Total Area	Percent of Total Area
SFLC2.3	South Fork Long Canyon below diversion	B	4514	562	0.171	7	1.7%	3	284	51	0.102	60	2.4	2	100	18	0.024	14	0.8	1	72	13	0.013	8	1	106	19	0.032	19
SFLC3.0	South Fork Long Canyon below diversion	B		505	0.163	7		3	255	51	0.100	62	27	2	100	20	0.019	12	0.9	1	60	12	0.017	10	1	90	18	0.027	17
SFLC4.2	South Fork Long Canyon above diversion	B3	4820	478	0.134	7	2.5%	3	222	46	0.066	49	2.9	2	106	22	0.033	25	1.0	1	60	13	0.006	5	1	90	19	0.029	22
SFLC5.2	South Fork Long Canyon above diversion	B3		435	0.100	7		3	181	42	0.051	51	1.9	2	99	23	0.024	24	0.8	1	65	15	0.012	12	1	90	21	0.012	12

<sup>1</sup>Peaking and bypass reach sites are channel typed to Level 1. Comparison sites are channel types to Level 1.

**APPENDIX B**  
**Reservoir Sampling Details and Maps**

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## **TABLES**

**Table B-1. 2007- 2008 Fish Population Reservoir Study Site Locations and Deployment Details.**

Year	Reservoir Location	Study Site	Net Deployment Location		Deployment		Retrieval		Net <sup>1</sup>	Net Depth (ft)	Bottom Depth (ft)	Total Time Deployed (hrs)
			Eastings	Northing	Date	Time	Date	Time				
<b>Ralston Afterbay</b>												
September 2007	Upper	RA-3A	696189	4319432	9/13/07	1840	9/14/07	1400	H	2 to 12	10 to 12	19.33
		RA-3B	696258	4319418	9/13/07	1850	9/14/07	1450	H	2 to 18	10 to 21	20.00
	Middle	RA-2A	695817	4319447	9/13/07	1820	9/14/07	1120	H	0 to 13	10 to 13	17.58
		RA-2B	695838	4319388	9/13/07	1830	9/14/07	1325	H	7 to 23	23 to 24	17.83
	Lower	RA-1A	695372	4319584	9/13/07	1740	9/14/07	1115	H	2 to 14	17 to 14	17.00
RA-1B		695286	4319489	9/13/07	1755	9/14/07	1145	H	2 to 18	10 to 18	18.92	
June 2008	Upper	RA-3A3	696189	4319432	6/26/08	1620	6/27/08	1330	H	0 to 9.5	5 to 9.5	21.17
		RA-3B3	696258	4319418	6/26/08	1610	6/27/08	1314	H	0 to 5	9.5 to 10	21.07
	Middle	RA-2A3	695817	4319447	6/26/08	1552	6/27/08	1201	H	0 to 16	5 to 16	20.15
		RA-2B3	695838	4319388	6/26/08	1559	6/27/08	1242	H	5 to 11	10 to 16	20.72
	Lower	RA-1A3	695372	4319584	6/26/08	1532	6/27/08	1129	H	5 to 11	9 to 13	19.95
RA-1B3		695286	4319489	6/26/08	1536	6/27/08	1110	H	17 to 24	25 to 30	19.57	
September <sup>2</sup> 2008	Upper	RA-3A3	696189	4319432	9/4/08	1604	9/5/08	1215	H	<b>0 to 8</b>	<b>10 to 12</b>	20.18
		RA-3C3	694883	4319470	9/4/08	1610	9/5/08	1240	H	<b>5 to 16</b>	<b>5 to 21</b>	20.50
	Middle	RA-2C3	695724	4319470	9/4/08	1546	9/5/08	1110	H	<b>2 to 17</b>	<b>10 to 24</b>	19.40
		RA-2D3	695926	4319281	9/4/08	1555	9/5/08	1135	H	<b>2 to 17</b>	<b>10 to 24</b>	19.67
	Lower	RA-1A3	695372	4319584	9/4/08	1530	9/5/08	945	H	<b>0 to 8</b>	<b>10 to 30</b>	18.25
RA-1C3		695474	4319587	9/4/08	1538	9/5/08	1050	H	<b>0 to 8</b>	<b>10 to 30</b>	19.20	
<b>Middle Fork Interbay</b>												
September 2007	Upper	INT-U1b	707777	4322342	9/20/07	1510	9/21/07	1030	H	0 to 14	10 to 14	19.33
	Middle	INT-U2b	707735	4322393	9/20/07	1454	9/21/07	1115	H	0 to 13	18 to 20	20.08
		INT-L1b2	707729	4322395	9/20/07	1530	9/21/07	1135	H	2 to 17	12 to 17	20.35
	Lower	INT-L2b	707657	4322432	9/20/07	1540	9/21/07	1150	H	5 to 19	15 to 19	20.17
<b>French Meadows Reservoir</b>												
September 2007	Upper	FM-1A	722966	4333020	9/11/07	1700	9/12/07	1930	H	10 to 25	20 to 40	26.50
		FM-1B	722920	4333036	9/11/07	1700	9/12/07	1700	H	7 to 18	25 to 38	24.00
		FM-1C	722843	4333029	9/12/07	1755	9/13/07	930	H	10 to 23	20 to 30	15.58
		FM-1D	722843	4333029	9/12/07	2000	9/13/07	947	H	7 to 25	15 to 30	13.78
	Middle	FM-2A	720581	4332566	9/11/07	1730	9/12/07	1610	H	15 to 40	30 to 70	22.67
		FM-2B	720492	4332549	9/11/07	1745	9/12/07	1530	H	30 to 58	50 to 95	21.75
		FM-2C	720486	4332539	9/12/07	1600	9/13/07	1030	H	20 to 58	50 to 80	18.5
		FM-2D	720580	4332447	9/12/07	1630	9/13/07	1040	V	12 to 112	112	18.17
	Lower	FM-3A	718964	4332088	9/11/07	1800	9/12/07	1500	H	40 to 58	80 to 100	21.00
		FM-3B	719077	4332448	9/11/07	1830	9/12/07	1550	H	30 to 48	40 to 75	21.33
FM-3C		719079	4332287	9/12/07	1445	9/13/07	1115	V	0 to 93	93	20.50	
FM-3D		719313	4332426	9/12/07	1515	9/13/07	1120	H	10 to 33	30 to 50	20.08	
<b>Hellhole Reservoir</b>												
September 2007	Upper	HH-1A	726943	4329443	9/10/07	1730	9/11/07	900	H	12 to 30	20 to 30	15.50
		HH-1B	726774	4329485	9/10/07	1700	9/11/07	1100	H	7 to 35	20 to 45	18.00
		HH-1C	726910	4329466	9/11/07	1045	9/12/07	755	H	5 to 20	25 to 36	21.17
		HH-1D	726775	4329435	9/11/07	1200	9/12/07	850	H	10 to 18	25 to 48	20.83
	Middle	HH-2A	725345	4328321	9/10/07	1830	9/11/07	1215	H	17 to 40	30 to 45	17.75
		HH-2C3	725313	4328274	9/11/07	1245	9/12/07	1030	H	17 to 27	30 to 40	21.75
	Lower	HH-3A	723905	4327476	9/10/07	1900	9/11/07	1345	H	22 to 60	40 to 80	18.75
		HH-3B	723963	4327484	9/10/07	1930	9/11/07	1420	H	32 to 80	50 to 120	18.83
		HH-3C	724104	4327709	9/11/07	1415	9/12/07	1115	H	7 to 50	25 to 70	21.00
		HH-3D	723893	4327480	9/11/07	1500	9/12/07	1153	H	22 to 86	49 to 86	20.88

<sup>1</sup>V=Vertical Net Deployment; H =Horizontal Net Deployment

<sup>2</sup>Placement of nets during September 2008 were modified for catching fish for methylmercury sampling. No nets were deployed on the bottom of the water column. Net depths were estimated.

<sup>3</sup>Approximate location, GPS Coordinates not recorded.

**Table B-2. 2007-2008 Summary of Fish Species Captured during Reservoir Gill Netting.**

Date	Reservoir Location	Study Site	Total Hours	Number of Fish <sup>1</sup> Captured							
				RBT	BNT	HH	SPM	SS	KOK	TCB	LKT
<b>Ralston Afterbay</b>											
September 2007	Upper	RA-3A	19.33	1	1		2	18			
		RA-3B	20.00	3	4	2		12			
		<b>Total</b>	<b>39.33</b>	<b>4</b>	<b>5</b>	<b>2</b>	<b>2</b>	<b>30</b>			
	Middle	RA-2A	17.00		3	2		11			
		RA-2B	18.92		2	1	2	10			
		<b>Total</b>	<b>35.92</b>		<b>5</b>	<b>3</b>	<b>2</b>	<b>21</b>			
	Lower	RA-1A	17.58	1		1		8			
		RA-1B	17.83	1				7			
		<b>Total</b>	<b>35.41</b>	<b>2</b>		<b>1</b>		<b>15</b>			
June 2008	Upper	RA-3A	21.17	3		3		18			
		RA-3B	21.07		1			11			
		<b>Total</b>	<b>42.24</b>	<b>3</b>	<b>1</b>	<b>3</b>		<b>29</b>			
	Middle	RA-2A	20.15	1	3			17			
		RA-2B	20.72	2	3		2	13			
		<b>Total</b>	<b>40.87</b>	<b>3</b>	<b>6</b>		<b>2</b>	<b>30</b>			
	Lower	RA-1A	19.95	2	1			16			
		RA-1B	19.57					9			
		<b>Total</b>	<b>39.52</b>	<b>2</b>	<b>1</b>			<b>25</b>			
September <sup>2</sup> 2008	Upper	RA-3A	20.18	4	1		1	14			
		RA-3C	20.50		1			8			
		<b>Total</b>	<b>117</b>	<b>4</b>	<b>2</b>		<b>1</b>	<b>22</b>			
	Middle	RA-2C	19.40					4			
		RA-2D	19.67					9			
		<b>Total</b>	<b>39.07</b>					<b>13</b>			
	Lower	RA-1A	18.25	1			1	15			
		RA-1C	19.20	1	2			3			
		<b>Total</b>	<b>37.45</b>	<b>2</b>	<b>2</b>		<b>1</b>	<b>18</b>			
<b>Middle Fork Interbay</b>											
September 2007	Upper	INT-U1b	19.33	1	3						
		<b>Total</b>	<b>19.33</b>	<b>1</b>	<b>3</b>						
	Middle	INT-L1b	20.35	1							
		INT-L2b	20.17		2						
		<b>Total</b>	<b>40.52</b>	<b>1</b>	<b>2</b>						
	Lower	INT-U2b	20.08	3	2						
<b>Total</b>		<b>20.08</b>	<b>3</b>	<b>2</b>							
<b>French Meadows Reservoir</b>											
September 2007	Upper	FM-1A	26.50	4	6						
		FM-1B	24.00		9						
		FM-1C	15.58		1						
		FM-1D	13.78		2						
		<b>Total</b>	<b>79.86</b>	<b>4</b>	<b>18</b>						
	Middle	FM-2A	22.67		2						
		FM-2B	21.75	2	3						
		FM-2C	18.5	1	1				1		
		FM-2D	18.17							1	
		<b>Total</b>	<b>81.09</b>	<b>3</b>	<b>6</b>				<b>1</b>	<b>1</b>	
	Lower	FM-3A	21.00								
		FM-3B	21.33		2						
		FM-3C	20.50								
		FM-3D	20.08	1	2						
		<b>Total</b>	<b>82.91</b>	<b>1</b>	<b>4</b>						
	<b>Hell Hole Reservoir</b>										
September 2007	Upper	HH-1A	15.50		2			30		1	1
		HH-1B	18.00		3			20		1	
		HH-1C	21.17		4			26	1		
		HH-1D	20.83		1			7			1
		<b>Total</b>	<b>75.50</b>		<b>10</b>			<b>83</b>	<b>1</b>	<b>2</b>	<b>2</b>
	Middle	HH-2A	17.75		2			5			
		HH-2C	21.75		1					1	
		<b>Total</b>	<b>39.50</b>		<b>3</b>			<b>5</b>		<b>1</b>	
	Lower	HH-3A	18.75		3			1	2		
		HH-3B	18.83		2			2	5	2	
		HH-3C	21.00		5			6	3	1	
		HH-3D	20.88					1	1		
		<b>Total</b>	<b>79.46</b>		<b>10</b>			<b>10</b>	<b>11</b>	<b>3</b>	

<sup>1</sup>Species: RBT = Rainbow Trout, BNT = Brown Trout, HH = Hardhead, SPM = Sacramento Pikeminnow, SS = Sacramento Sucker, KOK = Kokanee, TCB = Tui Chub, LKT = Lake Trout

<sup>2</sup>Placement of nets during September 2008 were modified for catching fish for methylmercury sampling. No nets were deployed on the bottom of the water column.

Table B-3. 2007-2008 Catch Per Unit Effort (CPUE) for Reservoir Gill Netting.

Date	Reservoir Location	Study Site	Total Hours	Number of Fish <sup>1</sup> Captured / Net Hour							
				RBT	BNT	HH	SPM	SS	KOK	TCB	LKT
<b>Ralston Afterbay</b>											
September 2007	Upper	FISH RA-3A	19.33	0.052	0.052	0.000	0.103	0.931			
		FISH RA-3B	20.00	0.150	0.200	0.100	0.000	0.600			
		<b>Total</b>	<b>39.33</b>	<b>0.102</b>	<b>0.127</b>	<b>0.051</b>	<b>0.051</b>	<b>0.763</b>			
	Middle	FISH RA-2A	17.00		0.176	0.118	0.000	0.647			
		FISH RA-2B	18.92		0.106	0.053	0.106	0.529			
		<b>Total</b>	<b>35.92</b>		<b>0.139</b>	<b>0.084</b>	<b>0.056</b>	<b>0.585</b>			
	Lower	FISH RA-1A	17.58	0.057		0.057		0.455			
		FISH RA-1B	17.83	0.056				0.393			
		<b>Total</b>	<b>35.41</b>	<b>0.056</b>		<b>0.028</b>		<b>0.424</b>			
June 2008	Upper	FISH RA-3A	21.17	0.142		0.142		0.850			
		FISH RA-3B	21.07		0.047			0.522			
		<b>Total</b>	<b>42.24</b>	<b>0.071</b>	<b>0.024</b>	<b>0.071</b>		<b>0.687</b>			
	Middle	FISH RA-2A	20.15	0.050	0.149			0.844			
		FISH RA-2B	20.72	0.097	0.145		0.097	0.627			
		<b>Total</b>	<b>40.87</b>	<b>0.073</b>	<b>0.147</b>		<b>0.049</b>	<b>0.734</b>			
	Lower	FISH RA-1A	19.95	0.100	0.050			0.802			
		FISH RA-1B	19.57					0.460			
		<b>Total</b>	<b>39.52</b>	<b>0.051</b>	<b>0.025</b>			<b>0.633</b>			
September <sup>2</sup> 2008	Upper	FISH RA-3A	20.18	0.198	0.050		0.050	0.694			
		FISH RA-3C	20.50		0.050			0.396			
		<b>Total</b>	<b>117.20</b>	<b>0.198</b>	<b>0.099</b>		<b>0.050</b>	<b>1.090</b>			
	Middle	FISH RA-2C	19.40					0.198			
		FISH RA-2D	19.67					0.446			
		<b>Total</b>	<b>39.07</b>					<b>0.644</b>			
	Lower	FISH RA-1A	18.25	0.050			0.050	0.743			
		FISH RA-1C	19.20	0.050	0.099			0.149			
		<b>Total</b>	<b>37.45</b>	<b>0.099</b>	<b>0.099</b>		<b>0.050</b>	<b>0.892</b>			
<b>Middle Fork Interbay</b>											
September 2007	Upper	FISH INT-U1b	19.33	0.052	0.155						
		<b>Total</b>	<b>19.33</b>	<b>0.05</b>	<b>0.16</b>						
	Middle	FISH INT-L1b	20.35	0.049							
		<b>Total</b>	<b>40.52</b>	<b>0.02</b>	<b>0.05</b>						
	Lower	FISH INT-U2b	20.08	0.149	0.100						
		<b>Total</b>	<b>20.08</b>	<b>0.15</b>	<b>0.10</b>						
<b>French Meadows Reservoir</b>											
September 2007	Upper	FISH FM-1A	26.50	0.151	0.226						
		FISH FM-1B	24.00	0.000	0.375						
		FISH FM-1C	15.58		0.064						
		FISH FM-1D	13.78		0.145						
		<b>Total</b>	<b>79.86</b>	<b>0.05</b>	<b>0.23</b>						
	Middle	FISH FM-2A	22.67		0.088						
		FISH FM-2B	21.75	0.092	0.138						
		FISH FM-2C	18.5	0.054	0.054			0.054			
		<b>Total</b>	<b>81.09</b>	<b>0.04</b>	<b>0.07</b>			<b>0.01</b>	<b>0.01</b>		
	Lower	FISH FM-3A	21.00								
		FISH FM-3B	21.33		0.094						
		FISH FM-3C	20.50								
		<b>Total</b>	<b>82.91</b>	<b>0.01</b>	<b>0.05</b>						
	<b>Hell Hole Reservoir</b>										
September 2007	Upper	FISH HH-1A	15.50		0.129			1.935		0.065	0.065
		FISH HH-1B	18.00		0.167			1.111		0.056	
		FISH HH-1C	21.17		0.189			1.228	0.047		
		FISH HH-1D	20.83		0.048			0.336			0.048
		<b>Total</b>	<b>75.50</b>		<b>0.13</b>			<b>1.10</b>	<b>0.01</b>	<b>0.03</b>	<b>0.03</b>
	Middle	FISH HH-2A	17.75		0.113			0.282			
		FISH HH-2C	21.75		0.046					0.046	
		<b>Total</b>	<b>39.50</b>		<b>0.08</b>			<b>0.13</b>	<b>0.00</b>	<b>0.03</b>	
	Lower	FISH HH-3A	18.75		0.160			0.053	0.107		
		FISH HH-3B	18.83		0.106			0.106	0.266	0.106	
		FISH HH-3C	21.00		0.238			0.286	0.143	0.048	
		<b>Total</b>	<b>79.46</b>		<b>0.13</b>			<b>0.13</b>	<b>0.14</b>	<b>0.04</b>	

<sup>1</sup>Species: RBT = Rainbow Trout, BNT = Brown Trout, HH = Hardhead, SPM = Sacramento Pikeminnow, SS = Sacramento Sucker, KOK = Kokanee, TCB = Tu Chub, LKT = Lake Trout

<sup>2</sup>Placement of nets during September 2008 were modified for catching fish for methylmercury sampling. No nets were deployed on the bottom of the water column.

**Table B-4. 2008 Ralston Afterbay Electrofishing Study Site Locations and Details.**

Study Site	Location		Sampling Period	Date	Time	Site length (m)
	Easting	Northing				
A	696706	4319496	Day	6/26/2008	1636	50
			Night	6/26/2008	1930	50
			Day	9/4/2008	2121	50
			Night	9/4/2008	2313	50
B	696536	4319703	Day	6/26/2008	1846	50
			Night	6/26/2008	2131	50
			Night	9/4/2008	1941	50
			Night	9/4/2008	2327	50
C	696291	4319666	Day	6/26/2008	1905	50
			Night	6/26/2008	2203	50
			Night	9/4/2008	2006	100
D	696293	4319540	Day	6/26/2008	1910	50
			Night	6/26/2008	2228	50
			Night	9/4/2008	2040	100
E	696276	4319424	Day	6/26/2008	1916	50
			Night	6/26/2008	2249	50
			Night	9/4/2008	2056	100
F	696091	4319343	Day	6/26/2008	1921	50
			Night	6/26/2008	2310	50
			Night	9/4/2008	2111	100
G	695885	4319310	Day	6/26/2008	1928	50
			Night	6/26/2008	2321	50
			Night	9/4/2008	2123	100
H	695804	4319496	Day	6/26/2008	1937	50
			Night	6/26/2008	2333	50
			Night	9/4/2008	2136	100
I	695506	4319303	Day	6/26/2008	1945	50
			Night	6/26/2008	2346	50
			Night	9/4/2008	2149	100
J	695514	4319526	Day	6/26/2008	1952	50
			Night	6/26/2008	2358	50
			Night	9/4/2008	2208	100
K	695268	4319510	Day	6/26/2008	2002	50
			Night	6/26/2008	2413	50
			Night	9/4/2008	2240	100

## MAPS

## **APPENDIX C**

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

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- Table C-3. Minimum and Maximum Fork Lengths of Fish Species Caught during Qualitative Sampling for Young-of-the-Year.

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- Map C-1. 2007 Trout Survey Upper Long Canyon Area.
- Map C-2. 2007 Trout Survey Duncan Creek Area.

## **Survey Notes of the Fish Distribution Sampling in South Fork Long Canyon Creek, North Fork Long Canyon Creek, and Duncan Creeks Upstream of the Diversions**

Fish distribution surveys of South Fork Long Canyon Creek, North Fork Long Canyon Creek, Duncan Creek, and Little Duncan Creek were conducted to determine the upstream limit of trout above the diversions. Surveys dates were between 8/13/2007 and 8/16/2007. Two surveyors followed the creek channel and sampled representative pools until the uppermost pool containing trout was reached. The dimensions (length, width, and maximum depth) of all pools, and discharge of the lower elevation pools were measured. The discharge at the pools farther upstream (higher elevation pools) was too small/shallow to be measured. Fish surveys were conducted by visual counts as the leading surveyor approached the pool or by snorkel. The counts were calibrated by conducting visual surveys and single pass electrofishing at three pools. Fish were identified to species and categorized into two age classes Young-of-the-Year (YOY) and juvenile/adult.

Rainbow trout were observed in both South Fork Long Canyon Creek and North Fork Long Canyon Creek. Rainbow trout and brown trout were observed in Duncan Creek and Little Duncan Creek. The numbers of trout observed in each pool loosely correlated with the size of the pool and the magnitude of inflow. A gradual decrease in flow and habitat connectivity was observed as the upstream limit of trout presence was approached. The upper limit of trout was pinpointed for all four streams sampled. Trout inhabited a majority of available habitats. In Duncan Creek and North Fork Long Canyon Creek trout were present until the stream habitat became too shallow or intermittent. In South Fork Long Canyon Creek and Little Duncan Creek the distribution ended at small barriers. It appeared, however, that these barriers limited the distribution due to insufficient flows. The exact upstream limits of trout on all four surveyed creeks may vary between years based on water year type, the magnitude of high spring flows, and the persistence of summer flows.

## South Fork Long Canyon Creek

---

surveyed 8/13/2007

### River Mile 5.75

*Habitat Type:* Plunge pool

*Notes:* Culvert forms a barrier at low flows

*Dimensions:* Drop pool is 5.5' deep 25-30' wide, 35' long

*Fish Count:* Approximately 40 Rainbow Trout (RBT) yearling to adult age range

*Flow:* 0.13 cfs



## South Fork Long Canyon Creek

---

surveyed 8/13/2007

*River Mile 5.8*

*Habitat Type:* Pool

*Notes:* None

*Dimensions:* 15' wide, 30' long, 2' deep

*Fish Count:* Approximately 15 yearling to adult, 12 young of the year (YOY)

*Flow:* 0.09 cfs



## South Fork Long Canyon Creek

---

surveyed 8/13/2007

### River Mile 8.1

*Habitat Type:* Pool

*Notes:* None

*Dimensions:* 15' long, 6' wide, 0.95' deep

*Fish Count:* Approximately 5 RBT YOY to yearling age range

*Flow:* Not measurable, stream is intermittent



### River Mile 8.3

*Habitat Type:* Pool

*Notes:* None

*Dimensions:* Not Available

*Fish Count:* 1 adult RBT present. Approximately 75 YOY were present in ~400 yards of intermittent pools and riffles

*Flow:* Not measurable

## South Fork Long Canyon Creek

---

surveyed 8/13/2007 (continued)

*River Mile 8.55*

**Upstream limit of trout in South Fork Long Canyon Creek (survey continued 0.85 miles upstream)**

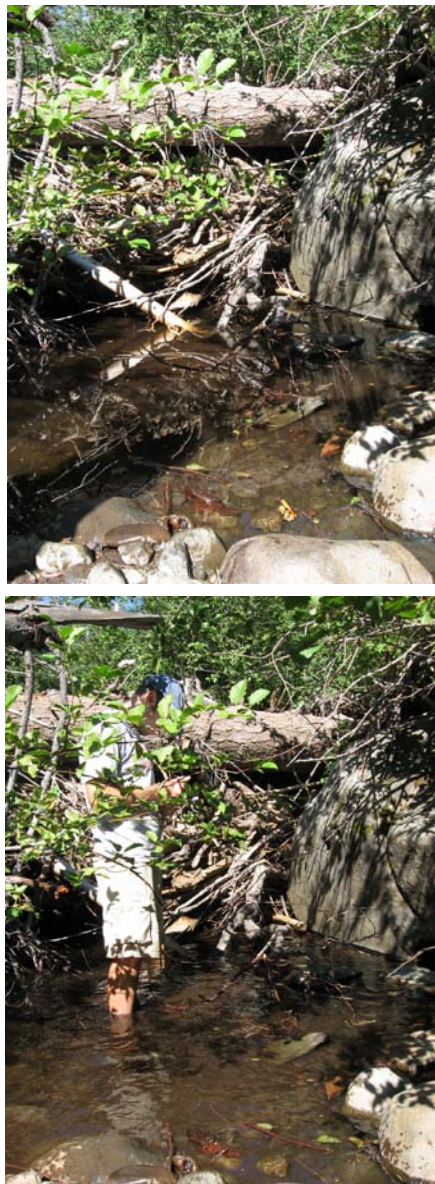
*Habitat Type:* Pool

*Notes:* None

*Dimensions:* 1' deep, 15' wide, 15' long. 6' tall debris jam at head of pool may act as a barrier

*Fish Count:* 1 yearling RBT

*Flow:* Not measurable



## South Fork Long Canyon Creek

---

surveyed 8/13/2007

*River Mile 9.4*

*Habitat Type:* Intermittent small pools

*Notes:* None

*Dimensions:* Not Available

*Fish Count:* No fish

*Flow:* No surface flow



## North Fork Long Canyon Creek

---

surveyed 8/14/2007

*River Mile 3.6*

*Habitat Type:* Pool

*Notes:* Pool was electrofished with a single thorough pass. We compared electrofishing count with visual estimate at three pools

*Dimensions:* 12' wide, 22' long, 1.1' deep.

*Fish Count:* Visual - 3 yearling to adult, 2 YOY  
E-fishing - 1 adult, 1 yearling, 2 YOY

*Flow:* 0.2 cfs



## North Fork Long Canyon Creek

---

surveyed 8/14/2007

*River Mile 3.6*

*Habitat Type: Pool*

*Notes: None*

*Dimensions: 13' wide, 20' long, 1.7' deep*

*Fish Count: Visual - 3 YOY, 10 yearling to adult*

*E-fishing 3 YOY, 8 yearling, 1 adult*

*Flow: Same as pool 1.*



## North Fork Long Canyon Creek

---

surveyed 8/14/2007

River Mile 3.6

*Habitat Type:* Pool

*Notes:* None

*Dimensions:* 12' wide, 25' long, 2.6' deep

*Fish Count:* Visual - 6-8 YOY, 3 yearling, 2 adult

E-fishing - 6 YOY, 3 yearling, 1 adult, 5-6 yearling to adult were missed

*Flow:* Same as pool 1



*Note:* A trial comparison shows that an initial visual count of trout present in the pool had roughly the same accuracy as single pass electrofishing. Visual counts of trout in pools had to be done quickly by the first person to encounter the pool as trout would scatter and hide very quickly. Visual counts from the surface were not able to determine species. In some pools a mask and snorkel were used and species could be identified.

## North Fork Long Canyon Creek

---

surveyed 8/14/2007

### River Mile 4.3

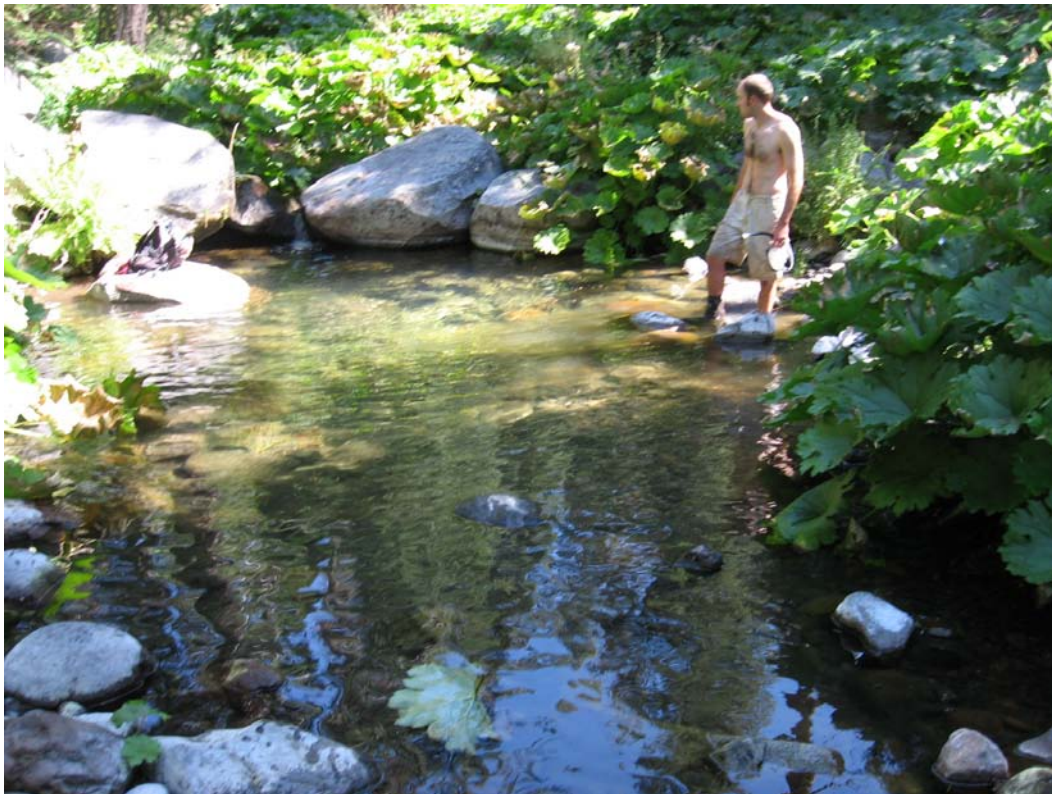
*Habitat Type:* Pool

*Notes:* Mid-channel pool

*Dimensions:* 19' wide, 34' long, 4.5' deep

*Fish Count:* 2 YOY, 14 yearling to adult

*Flow:* 0.09 cfs



### River Mile 4.8

*Habitat Type:*

*Notes:* None

*Dimensions:* 7' wide, 12' long, 0.85' deep

*Fish Count:* 3 YOY

*Flow:* Not measurable

## North Fork Long Canyon Creek

---

surveyed 8/14/2007

### River Mile 4.9

### **Upstream limit of trout in North Fork Long Canyon Creek (survey continued 0.2 miles upstream)**

*Habitat Type:* Isolated pool

*Notes:* Heavy algal growth, temperature very stratified, channel mostly dry upstream

*Dimensions:* 6' wide, 16' long, 1' deep

*Fish Count:* 3 YOY, 1 yearling

*Flow:* No surface flow



## **Little Duncan Creek**

---

surveyed 8/15/2007 and 8/16/2007

*River Mile 0.45*

*Habitat Type: Pool*

*Notes:* Creek is very high gradient through this reach with steep bedrock cascades and scour pools and numerous potential migration barriers

*Dimensions:* Pool 25' wide, 45' long, 4' deep

*Fish Count:* 6 YOY

*Flow:* 0.07 cfs



## **Little Duncan Creek**

---

surveyed 8/15/2007 and 8/16/2007

*River Mile 0.8*

*Habitat Type: Pool*

*Notes: None*

*Dimensions: 18' wide, 35' long, 2.25' deep*

*Fish Count: 2 adult*

*Flow: Not measurable*



## **Little Duncan Creek**

---

surveyed 8/15/2007 and 8/16/2007

### River Mile 1.2

*Habitat Type:* Pool

*Notes:* Confluence of Little Duncan Creek (LDC) headwater and Little Robinson Valley (LRV) headwater. No fish detected on LRV creek ~200 meters above the confluence. Bedrock sheet cascade on LRV creek may be migration impediment

*Dimensions:* 8' wide, 20' long, 1.0' deep

*Fish Count:* 2 YOY

*Flow:* Not measurable



## **Little Duncan Creek**

surveyed 8/15/2007 and 8/16/2007

---

### *River Mile 1.2 – Pool 4*

*Habitat Type:* Pool

*Notes:* LDC headwater above confluence with LRV creek

*Dimensions:* 7.5' wide, 17' long, 0.9' deep

*Fish Count:* 2 YOY

*Flow:* Not measurable



## **Little Duncan Creek**

---

surveyed 8/15/2007 and 8/16/2007

### River Mile 1.3 – Pool 5

#### **Upstream limit of trout in Little Duncan Creek (survey continued 1.4 miles upstream)**

*Habitat Type:* Bedrock Pool

*Notes:* Upstream passage blocked by steep bedrock sheet cascade. Downstream passage blocked at low flow by cobbles, boulders, and debris. Flow is not measurable. Very low surface flow extends upstream from this pool. Higher bedrock barriers below this point did not appear to affect the distribution of trout. Perhaps there was insufficient flow depth for adult fish to pass this barrier.

*Dimensions:* 25' wide, 20' long, 4.2' deep

*Fish Count:* 1 yearling unidentified trout, 1 large adult Brown Trout (BNT)

*Flow:* Not Available



## **Duncan Creek**

---

surveyed 8/16/07

*River Mile 12.4*

*Habitat Type: Step-Pool*

*Notes: None*

*Dimensions: 10' wide, 28' long, 1.0' deep*

*Fish Count: 2 yearling to adult, 1 YOY*

*Flow: 0.13 cfs*



## **Duncan Creek**

---

surveyed 8/16/07

*River Mile 12.5*

*Habitat Type: Pool*

*Notes: None*

*Dimensions: 21' wide, 60' long, 1.6' deep*

*Fish Count: Approximately 10 yearling to adult*

*Flow: Similar to pool 1*



## **Duncan Creek**

---

surveyed 8/16/07

*River Mile 12.85*

*Habitat Type: Pool*

*Notes: None*

*Dimensions: 6' wide, 20' long, 1.0' deep*

*Fish Count: 2 adult*

*Flow: Not measurable*



## **Duncan Creek**

---

surveyed 8/16/07

River Mile 13.3

**Upstream extent of trout in Duncan Creek (survey continued 0.3 miles upstream)**

*Habitat Type:* Pool

*Notes:* None

*Dimensions:* 8' wide, 19' long, 0.75' deep

*Note:* Very little habitat upstream, very low surface flow upstream of this point

*Fish Count:* 3 YOY

*Flow:* Not measurable



## **Duncan Creek**

---

surveyed 8/16/07

### River Mile 13.6

*Habitat Type:* Bedrock Sheet

*Notes:* Upstream extent of survey on Duncan Creek. Flow is only a steep trickle over bedrock and claypan, very little habitat

*Dimensions:* Not Available

*Fish Count:* No fish

*Flow:* Not measurable



## **TABLES**

**Table C-1. The Upstream Extent of the Distribution in South Fork Long Canyon, North Fork Long Canyon, and Duncan Creek above the Diversion Dams.**

<b>Stream</b>	<b>River mile of diversion dam</b>	<b>River miles surveyed</b>	<b>River mile of upstream most fish</b>	<b>Length of stream above diversion with fish present (miles)</b>	<b>Species Present<sup>3</sup></b>
North Fork Long Canyon Creek	3.1	3.5 - 3.7, 4.2 - 4.1, 4.7 - 5.1	4.9	1.8	RBT
South Fork Long Canyon Creek	3.2	5.6 - 5.9, 7.9 - 9.4	8.55	5.35	RBT
Duncan Creek	8.6	8.6 - 9.5, 12.4 - 13.6	13.3	4.7	RBT, BNT
Little Duncan Creek <sup>1</sup>	--	0.0 - 2.7	1.3	2.2 <sup>2</sup>	RBT, BNT

<sup>1</sup>Little Duncan Creek branches off of Duncan Creek approximately 0.9 miles upstream of the Duncan Diversion Dam

<sup>2</sup>Total length includes the 0.9 mile between the Duncan Diversion Dam and Little Duncan Creek

<sup>3</sup>RBT = rainbow trout, BNT = brown trout

**Table C-2. Summary of the Upstream Distribution Sampling<sup>1</sup> for South Fork Long Canyon, North Fork Long Canyon, and Duncan Creek above the Diversion Dams.**

Study Site	Flow (cfs)	Habitat Units Sampled	Length Sampled (ft)	Number of YOY <sup>2</sup> (fish/10 ft)	Number of Juvenile/Adult (fish/10 ft)
<b>South Fork Long Canyon</b>					
River Mile 5.75	0.13	1 plunge pool	35	0	40 (11.4)
River Mile 5.8	0.09	1 pool	30	12 (4)	15 (5)
River Mile 8.1	NA <sup>3</sup>	1 pool	15	4 (2.6)	1 (0.7)
<b>River Mile 8.55 (upstream limit)</b>	<b>NA<sup>3</sup></b>	<b>1 pool</b>	<b>15</b>	<b>0</b>	<b>1 (0.7)</b>
<b>North Fork Long Canyon</b>					
River Mile 3.6	0.2	3 pools	67	11 (1.6)	18 (2.7)
River Mile 4.3	0.09	1 pool	34	2 (0.6)	14 (4.1)
River Mile 4.8	NA <sup>3</sup>	1 pool	12	3 (2.5)	0
<b>River Mile 4.9 (upstream limit)</b>	<b>NA<sup>3</sup></b>	<b>1 pool</b>	<b>16</b>	<b>3 (1.9)</b>	<b>1 (0.6)</b>
<b>Little Duncan Creek</b>					
River Mile 0.45	0.07	1 pool	45	6 (1.3)	0
River Mile 0.8	NA <sup>3</sup>	1 pool	35	0	2 (0.6)
River Mile 1.2 (Little Robison Valley confluence)	NA <sup>3</sup>	1 pool	20	2 (1)	0
River Mile 1.2	NA <sup>3</sup>	1 pool	17	2 (1.2)	0
<b>River Mile 1.3 (upstream limit)</b>	<b>NA<sup>3</sup></b>	<b>1 plunge pool</b>	<b>20</b>	<b>0</b>	<b>2 (1)</b>
<b>Duncan Creek</b>					
River Mile 12.4	0.13	1 step pool	28	1 (0.4)	2 (0.7)
River Mile 12.5	NA <sup>3</sup>	1 pool	60	0	10 (1.7)
River Mile 12.85	NA <sup>3</sup>	1 pool	20	0	2 (1)
<b>River Mile 13.3 (upstream limit)</b>	<b>NA<sup>3</sup></b>	<b>1 pool</b>	<b>19</b>	<b>3 (1.6)</b>	<b>0</b>

<sup>1</sup>Note: Only Locations with fish are shown. Pools above the upstream limit of the fish distribution were sampled.

<sup>2</sup>YOY =Young-of-the-Year.

<sup>3</sup>NA=Depth too shallow to measure flow.

**Table C-3. Minimum and Maximum Fork Lengths of Fish Species Caught during Qualitative Sampling for Young-of-the-Year (YOY).**

Date	Number of Habitat Units Sampled	Total Length Sampled	Minimum - Maximum Fork Length (mm) by Fish Species <sup>1</sup>									
			RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	
<b>Middle Fork American River Upstream of Ralston Afterbay</b>												
6/5/2007	3	600	22-44 (n=9)	45-75 (n=5)	46-65 (n=4)	22-97 (n=68)	20-24 (n=4)	48-96 (n=24)	23-71 (n=32)	54-55 (n=2)	63-63 (n=1)	
6/25/2007	3	600	-	80-80 (n=1)	52-130 (n=24)	52-93 (n=20)	8-24 (n=69)	17-105 (n=48)	54-101 (n=5)	-	42-65 (n=7)	
7/16/2007	3	600	49-49 (n=1)	72-72 (n=1)	53-139 (n=16)	61-93 (n=11)	15-32 (n=48)	22-87 (n=16)	27-73 (n=13)	-	53-68 (n=5)	
<b>Gas Canyon Creek</b>												
5/11/2007	2	120	23-135 (n=65)	55-55 (n=1)	-	-	-	-	59-75 (n=3)	-	-	
<b>Rubicon River upstream of Ralston Powerhouse</b>												
5/11/2007	3	471	-	-	33-69 (n=26)	28-98 (n=56)	-	57-86 (n=3)	-	-	28-48 (n=9)	
6/7/2007	3	471	39-49 (n=3)	-	48-73 (n=8)	31-67 (n=35)	8-19 (n=63)	41-67 (n=21)	17-71 (n=21)	-	-	
6/27/2007	3	471	38-38 (n=1)	-	-	48-77 (n=14)	12-25 (n=44)	32-103 (n=3)	33-72 (n=5)	48-55 (n=4)	38-63 (n=22)	
7/17/2007	3	471	-	-	-	25-88 (n=9)	13-39 (n=55)	43-92 (n=3)	37-74 (n=6)	28-42 (n=7)	36-60 (n=25)	
<b>North Fork Long Canyon upstream of Diversion Pool</b>												
5/17/2007	1	400	64-105 (n=8)	-	-	-	-	-	-	-	-	
6/6/2007	1	400	23-198 (n=33)	-	-	-	-	-	-	-	-	
6/26/2007	1	400	28-185 (n=68)	-	-	-	-	-	-	-	-	
<b>South Fork Long Canyon upstream of Diversion Pool</b>												
5/17/2007	1	622	80-141 (n=8)	-	-	-	-	-	-	-	-	
6/6/2007	1	622	85-182 (n=18)	-	-	-	-	-	-	-	-	
6/26/2007	1	622	28-192 (n=26)	-	-	-	-	-	-	-	-	
<b>Duncan Creek upstream of Diversion Pool</b>												
5/17/2007	1	531	108-183 (n=2)	-	-	-	-	-	-	-	-	
6/6/2007	1	531	85-115 (n=5)	-	-	-	-	-	-	-	-	
6/26/2007	1	531	30-188 (n=18)	84-225 (n=3)	-	-	-	-	-	-	-	

<sup>1</sup>Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pike Minnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SD = Speckled Dace; CAR = California Roach

## MAPS

**APPENDIX D**

**Quantitative Fish Population Sampling Data**

**List of Tables**

- Table D-1. 2007–2009 Summary of Fish Sampled at River Sampling Sites.
- Table D-2. 2007–2009 Fish Population Estimates at Each River Sampling Site for Electrofishing and Snorkeling.
- Table D-3. The 2007 Average Length and Number of Scale Aged Rainbow Trout, Brown Trout, Hardhead, and Sacramento Pikeminnow in the Study Streams.
- Table D-4. 2007–2009 Length-Weight Regression for Rainbow Trout and Brown Trout.

## **TABLES**

**Table D-1. 2007-2009 Summary of Fish Sampled at River Sampling Sites.<sup>1</sup>**

Study Site	DATE	Sample Type <sup>2</sup>	RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	WCF
<b>Middle Fork American River Downstream of Ralston Afterbay</b>														
MF4.8	10/3/07	QUANT	104	14			450	610	5					
MF4.8	10/3/07	QUAL				2		2	10					
MF4.8	9/29/08	QUANT	24	10				23						
MF14.1	10/2/07	QUANT	196	44				2	5					
Otter Creek at MF14.1	10/2/07; 10/16/07	QUAL	2		2		20	3			23			
MF14.1	9/30/08	QUANT	52	8				1						
Gas Canyon	5/7/07	QUAL	65	1					3					
MF23.5	10/8/08	QUANT	249	25										
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>														
MF26.2	9/18/07	QUANT	81	3	1	22	60	37		9	44			
MFAR upstream of Ralston Afterbay	6/5/07; 6/25/07; 7/16/07	QUAL	10	7	44	99	121	91	50	2	13			
MF26.2	9/15/08	QUANT	70	2	5	32	39	9	143	5	27			
MFAR at 29.4	10/24/07	QUAL	15	10										
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>														
MF36.2	9/21/07	QUANT	226	27										
MF44.7	9/26/07	QUANT	72	96										
MF44.7	10/27/08	QUANT	64	43										
MF51.8	10/11/07	QUANT	308	244										
<b>Rubicon River</b>														
Rubicon upstream of Ralston Powerhouse	5/11/07; 6/7/07; 6/27/07; 7/17/07	QUAL	4		34	114	163	30	32	11	56			
Rubicon at RM 3.5	6/12/07	QUAL			2 <sup>3</sup>									
R3.5	9/17/07	QUANT	54	1		8		1	1	11	17			
R20.9	9/19/07	QUANT	302	10										
R20.9	9/26/08	QUANT	139	4										
R25.7	9/25/07	QUANT	131	19										
R36.2	9/27/07	QUANT	178	13						156				
<b>Long Canyon Creek</b>														
LC9.0	10/8/07	QUANT	656											
<b>North Fork Long Canyon Creek</b>														
NFLC1.9	8/30/07	QUANT	344											
NFLC3.8	9/5/07	QUANT	284											
NFLC upstream of diversion pool	5/17/07; 6/16/07; 6/26/07	QUAL	109											

<sup>1</sup>Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pikeminnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SCULP = Sculpin; SD = Speckled Dace; CAR = California Roach; SMB = Smallmouth Bass; GSUN = Green Sunfish; WCF = White Catfish

<sup>2</sup>QUAL= Qualitative Sampling; QUANT = Quantitative sampling

<sup>3</sup>Several small hardhead were qualitatively captured with a dipnet

**Table D-1. 2007-2009 Summary of Fish Sampled at River Sampling Sites (continued).<sup>1</sup>**

Study Site	DATE	Sample Type <sup>2</sup>	RBT	BNT	HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	WCF
<b>South Fork Long Canyon Creek</b>														
SFLC2.3	8/28/07	QUANT	436											
SFLC2.3	9/9/08	QUANT	512											
SFLC2.3	10/5/09	QUANT	227											
SFLC3.0	10/6/09	QUANT	198											
SFLC4.2	8/29/07	QUANT	366											
SFLC4.2	9/10/08	QUANT	443											
SFLC4.2	10/7/09	QUANT	231											
SFLC5.0	10/8/09	QUANT	146											
SFLC upstream of diversion pool	5/17/07; 6/16/07; 6/26/07	QUAL	52											
<b>Duncan Creek</b>														
D6.3	9/6/07	QUANT	225	53										
D6.3	10/22/08	QUANT	219	48										
D8.3	10/23/08	QUANT	252	31										
D9.0	9/7/07	QUANT	209	9										
D9.0	10/28/08	QUANT	245	8										
D10.0	10/29/08	QUANT	163	11										
Duncan upstream of diversion pool	5/17/07; 6/16/07; 6/26/07	QUAL	25	3										
<b>North Fork of the Middle Fork American River</b>														
NFMF2.3	10/1/07	QUANT	106			2		24		58	251			
NFMF2.3	9/24/08	QUANT	70			7					325			
<b>North Fork American River</b>														
NF18.4	10/9/07	QUANT	52	1				19	6					
NF31.3	10/21/07	QUANT	3			14	34	6	3			4	2	
NF at 31.3	10/21/07	QUAL				27		16	15			88	12	2
NF53.7	8/31/07	QUANT	138			6	1112	63		26	10			
NF53.7	9/25/08	QUANT	100	0		8	10	19	2	33	44			

<sup>1</sup>Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hardhead; SPM = Sacramento Pikeminnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SCULP = Sculpin; SD = Speckled Dace; CAR = California Roach; SMB = Smallmouth Bass; GSUN = Green Sunfish; WCF = White Catfish

<sup>2</sup>QUAL= Qualitative Sampling; QUANT = Quantitative sampling

**Table D-2. 2007-2009 Fish Population Estimates at Each River Sampling Site for Electrofishing and Snorkeling.**

Study Site	Year	Sample Type <sup>1</sup>	Total Length Sampled (ft)	Area Sampled (acres)	Fish Species <sup>2</sup> Population Estimate ± 95% Confidence Interval <sup>3</sup>													
					RBT		BNT		HH	SPM	MXD	SS	SCULP	SD	CAR	SMB	GSUN	
					Pop Est	Avg Wt (g) <sup>4</sup>	Pop Est	Avg Wt (g) <sup>4</sup>										
<b>Middle Fork American River Downstream of Ralston Afterbay</b>																		
MF4.8	2007	S	3877	10.056	104	279	14	681	--	--	450	610	5	--	--	--	--	--
	2008	S	3877	10.056	24	412	10	383	--	--	--	23	--	--	--	--	--	--
MF14.1	2007	S	3374	8.329	196	359	44	699	--	--	--	2	5	--	--	--	--	--
	2008	S	3374	8.329	52	250	8	370	--	--	--	1	--	--	--	--	--	--
MF23.5	2008	S	3531	7.550	249	271	25	470	--	--	--	--	--	--	--	--	--	--
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>																		
MF26.2	2007	E	302	0.290	35±4	33	3±0	445	1±0	22±2	0±0	42±20	128±90	9±6	48±3	--	--	--
		S	765	0.749	46	93	0	0	0	0	60	0	0	0	2	--	--	--
	2008	E	311	0.287	24±3	53	2±4	23	0±0	0±0	0±0	9±1	148±17	5±16	9±0	--	--	--
		S	669	0.749	43	72	0	0	5	32	39	0	0	0	19	--	--	--
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>																		
MF36.2	2007	E	204	0.133	223±37	11	26±10	8	--	--	--	--	--	--	--	--	--	--
		S	330	0.262	31	132	3	267	--	--	--	--	--	--	--	--	--	--
MF44.7	2007	E	222	0.163	39±10	8	43±5	45	--	--	--	--	--	--	--	--	--	--
		S	488	0.435	35	30	53	29	--	--	--	--	--	--	--	--	--	--
	2008	E	238	0.124	26±14	23	17±3	58	--	--	--	--	--	--	--	--	--	--
		S	391	0.255	41	54	26	35	--	--	--	--	--	--	--	--	--	--
MF51.8	2007	E	660	0.655	314±22	4	257±26	4	--	--	--	--	--	--	--	--	--	
<b>Rubicon River</b>																		
R3.5	2007	E	156	0.364	20±6	75	0±0	0	--	11±26	0±0	1±0	234±0	210±13	1±0	--	--	--
		S	1163	1.624	34	125	1	771	--	0	1445	0	1	0	16	--	--	--
R20.9	2007	E	204	0.171	236±26	24	7±1	77	--	--	--	--	--	--	--	--	--	--
		S	1020	1.516	89	102	3	352	--	--	--	--	--	--	--	--	--	--
	2008	E	220	0.197	146±35	28	3±2	200	--	--	--	2±5	--	--	--	--	--	--
		S	1020	1.516	16	111	1	465	--	--	--	0	--	--	--	--	--	--
R25.7	2007	E	268	0.235	103±9	14	20±15	22	--	--	--	--	--	--	--	--	--	--
		S	145	0.555	29	215	0	0	--	--	--	--	--	--	--	--	--	--
R36.2	2007	E	688	0.440	187±26	14	13±1	5	--	--	--	--	--	239±29	--	--	--	
<b>Long Canyon Creek</b>																		
LC9.0	2007	E	543	0.203	687±44	9	--	--	--	--	--	--	--	--	--	--	--	--
<b>North Fork Long Canyon Creek</b>																		
NFLC1.9	2007	E	399	0.121	361±32	11	--	--	--	--	--	--	--	--	--	--	--	--
NFLC3.8	2007	E	431	0.116	286±12	11	--	--	--	--	--	--	--	--	--	--	--	--
<b>South Fork Long Canyon Creek</b>																		
SFCL2.3	2007	E	555	0.157	461±44	9	--	--	--	--	--	--	--	--	--	--	--	--
	2008	E	560	0.169	534±39	9	--	--	--	--	--	--	--	--	--	--	--	--
	2009	E	562	0.171	233±19	16	--	--	--	--	--	--	--	--	--	--	--	--
SFCL3.0	2009	E	505	0.163	240±135	13	--	--	--	--	--	--	--	--	--	--	--	--
	2007	E	425	0.099	437±30	8	--	--	--	--	--	--	--	--	--	--	--	--
SFCL4.2	2008	E	476	0.113	447±15	12	--	--	--	--	--	--	--	--	--	--	--	--
	2009	E	478	0.134	233±11	16	--	--	--	--	--	--	--	--	--	--	--	--
		2009	E	435	0.100	148±13	18	--	--	--	--	--	--	--	--	--	--	--
<b>Duncan Creek</b>																		
D6.3	2007	E	446	0.206	232±24	12	55±15	23	--	--	--	--	--	--	--	--	--	--
	2008	E	456	0.219	226±23	16	48±6	33	--	--	--	--	--	--	--	--	--	--
D8.3	2008	E	439	0.169	257±18	18	31±6	23	--	--	--	--	--	--	--	--	--	--
D9.0	2007	E	457	0.223	211±15	16	12±0	23	--	--	--	--	--	--	--	--	--	--
	2008	E	458	0.202	248±14	16	8±6	58	--	--	--	--	--	--	--	--	--	--
D10.0	2008	E	446	0.186	164±5	27	11±6	47	--	--	--	--	--	--	--	--	--	--
<b>North Fork of the Middle Fork American River</b>																		
NFMF2.3	2007	E	283	0.293	77±10	24	--	--	--	2±0	--	31±26	46±19	117±470	201±24	--	--	--
		S	535	0.487	33	78	--	--	--	0	--	0	0	5	63	--	--	--
	2008	E	303	0.327	54±7	38	--	--	--	4±0	0±0	45±9	33±5	66±2	129±7	--	--	--
		S	561	0.515	20	150	--	--	--	3	589	0	0	0	198	--	--	--
<b>North Fork American River</b>																		
NF18.4	2007	S	4162	11.019	52	294	1	771	--	--	--	19	6	--	--	--	--	--
NF31.3	2007	S	3195	6.792	3	140	--	--	--	14	34	6	3	--	--	4	2	--
		E	189	0.169	22±4	51	--	--	--	6±0	0±0	24±117	5±0	26±2	10±1	--	--	--
NF53.7	2007	S	1752	2.586	117	120	--	--	--	0	1112	54	0	0	26	--	--	--
		E	189	0.208	17±1	38	--	--	--	8±0	0±0	19±2	2±0	36±8	44±2	--	--	--
	2008	S	1634	2.587	83	170	--	--	--	0	10	0	0	0	0	--	--	--

<sup>1</sup>S = snorkeling; E = electrofishing

<sup>2</sup>Species: RBT = Rainbow Trout; BNT = Brown Trout; HH = Hard Head; SPM = Sacramento Pike Minnow; MXD = Mixed Minnow; SS = Sacramento Sucker; SCULP = Sculpin; SD = Speckled Dace; CAR = California Roach; SMB = Small Mouth Bass; GSUN = Green Sunfish

<sup>3</sup>Confidence intervals are not available for snorkeling population estimates

<sup>4</sup>See methods in text for details on average weight calculations

**Table D-3. The 2007 Average Length and Number of Scale Aged Rainbow Trout, Brown Trout, Hardhead, and Sacramento Pikeminnow in the Study Streams.**

Study Site	Average Length (mm) at Age (sample size)																			
	Rainbow Trout					Brown Trout					Hardhead					Sacramento Pikeminnow				
	0+	1+	2+	3+	4+	0+	1+	2+	3+	4+	0+	1+	2+	3+	4+	0+	1+	2+	3+	4+
<b>Middle Fork American River Downstream of Ralston Afterbay</b>																				
MF4.8																				
MF14.1	104.5 (8)	210.3 (3)	305.5 (2)	322.0 (2)	363.0 (1)					385.0 (1)		106.5 (2)								
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>																				
MF26.2	77.3 (6)	152.5 (24)	212.7 (3)			88.0 (1)		269.0 (1)		423.0 (1)							117.0 (1)			
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>																				
MF36.2	65.9 (14)	149.6 (42)	210.0 (4)			77.4 (24)	220.0 (1)													
MF44.7	74.9 (27)	132.8 (4)	174.0 (1)			84.6 (25)	161.8 (4)	194.2 (12)												
MF51.8	86.7 (14)	134.1 (13)				78.3 (9)	127.5 (2)													
<b>Rubicon River</b>																				
R3.5	79.5 (6)	181.4 (9)	295.3 (3)	343.0 (1)																
R20.9	76.8 (11)	136.4 (27)	200.7 (18)	252.5 (2)		88.3 (3)		223.8 (4)												
R25.7	70.5 (30)	131.9 (21)	200.6 (5)			87.9 (15)	166.0 (6)	196.0 (2)												
R36.2	62.8 (12)	138.4 (29)	190.5 (8)	280.7 (3)		77.4 (14)														
<b>Long Canyon Creek</b>																				
LC9.0	80.6 (22)	143.8 (26)	197.0 (12)	222.3 (4)																
<b>North Fork Long Canyon Creek</b>																				
NFLC1.9		153.8 (5)	178.0 (3)	198.0 (1)																
NFLC3.8	59.7 (3)	115.0 (8)	154.3 (3)	185.0 (1)																
<b>South Fork Long Canyon Creek</b>																				
SFLC2.3		121.2 (5)	161.0 (11)	199.5 (2)																
SFLC4.2		119.3 (4)	148.3 (7)	188.0 (4)																
<b>Duncan Creek</b>																				
D6.3	61.5 (2)	134.6 (8)	167.5 (4)	196.0 (1)		79.7 (3)	133.0 (1)	188.5 (2)	228.0 (4)											
D9.0	76.0 (2)	122.5 (6)	173.6 (5)	201.0 (1)		49.5 (2)	139.5 (2)		218.0 (1)											
<b>North Fork of the Middle Fork American River</b>																				
NFMF2.3	85.4 (16)	143.8 (16)	222.3 (6)	260.0 (1)																
<b>North Fork American River</b>																				
NF18.4																				
NF31.3																80.4 (5)	131.3 (4)			
NF53.7		165.3 (7)	228.8 (4)																	

Table D-4. 2007-2009 Length-Weight Regression for Rainbow Trout and Brown Trout.

Study Site	Year	Rainbow Trout Length-Weight Equation ( $W=aL^b$ ) <sup>1</sup>					Brown Trout Length-Weight Equation ( $W=aL^b$ ) <sup>1</sup>				
		a	b	n	Range <sup>2</sup>	Alternate Equation Used	a	b	n	Range <sup>2</sup>	Alternate Equation Used
<b>Middle Fork American River Downstream of Ralston Afterbay</b>											
MF4.8	2007	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
	2008	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
MF14.1	2007	1.137E-05	2.968	16	Poor	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
	2008	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
MF23.5	2008	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
<b>Middle Fork American River from Middle Fork Interbay to Ralston Afterbay</b>											
MF26.2	2007	3.468E-06	3.215	33	Good	--	4.092E-06	3.201	3	Poor	Project Wide BNT <sup>4</sup>
	2008	7.082E-06	3.088	27	Poor	Project Wide RBT <sup>4</sup>	2.468E-05	2.830	2	Poor	Project Wide BNT <sup>4</sup>
<b>Middle Fork American River Upstream of Middle Fork Interbay</b>											
MF36.2	2007	1.232E-06	3.412	169	Good	--	4.659E-07	3.627	24	Poor	Project Wide BNT <sup>4</sup>
MF44.7	2007	3.336E-06	3.234	37	Good	--	9.173E-06	3.031	43	Good	--
	2008	3.298E-06	3.240	17	Poor	Project Wide RBT <sup>4</sup>	1.314E-05	2.962	23	Poor	Project Wide BNT <sup>4</sup>
MF51.8	2007	1.236E-06	3.442	132	Good	--	6.869E-07	3.569	110	Poor	Project Wide BNT <sup>4</sup>
<b>Rubicon River</b>											
R3.5	2007	6.474E-06	3.094	20	Good	--			0		
R20.9	2007	2.604E-06	3.274	187	Good	--	7.090E-06	3.087	6	Poor	Project Wide BNT <sup>4</sup>
	2008	6.880E-06	3.093	122	Poor	Project Wide RBT <sup>4</sup>	3.922E-06	3.196	3	Poor	Project Wide BNT <sup>4</sup>
R25.7	2007	2.036E-06	3.336	101	Good	--	6.340E-06	3.110	19	Good	--
R36.2	2007	4.360E-06	3.177	177	Good	--	6.100E-07	3.615	13	Poor	Project Wide BNT <sup>4</sup>
<b>Long Canyon Creek</b>											
LC9.0	2007	4.209E-06	3.192	377	Good	--	NA	NA	0	NA	NA
<b>North Fork Long Canyon Creek</b>											
NFLC1.9	2007	1.021E-05	3.007	125	Good	--	NA	NA	0	NA	NA
NFLC3.8	2007	1.050E-05	2.999	280	Good	--	NA	NA	0	NA	NA
<b>South Fork Long Canyon Creek</b>											
SFLC2.3	2007	8.586E-06	3.050	73	Good	--	NA	NA	0	NA	NA
	2008	1.675E-06	3.395	418	Good	--	NA	NA	0	NA	NA
	2009	1.172E-05	3.001	228	Good	--	NA	NA	0	NA	NA
SFLC3.0	2009	1.061E-05	3.012	199	Good	--	NA	NA	0	NA	NA
SFLC4.2	2007	6.529E-06	3.108	62	Good	--	NA	NA	0	NA	NA
	2008	3.176E-06	3.253	375	Good	--	NA	NA	0	NA	NA
	2009	4.583E-06	3.182	233	Good	--	NA	NA	0	NA	NA
SFLC5.2	2009	2.083E-06	3.341	147	Good	--	NA	NA	0	NA	NA
<b>Duncan Creek</b>											
D6.3	2007	8.990E-06	3.042	225	Good	--	1.218E-05	2.974	53	Good	--
	2008	6.380E-06	3.113	219	Good	--	1.095E-05	2.999	47	Good	
D8.3	2008	5.930E-06	3.118	250	Good	--	1.733E-05	2.904	30	Good	
D9.0	2007	1.123E-05	3.005	208	Good	--	1.743E-05	2.906	9	Poor	Project Wide BNT <sup>4</sup>
	2008	8.657E-06	3.053	245	Good	--	8.079E-06	3.065	8	Poor	
D10.0	2008	4.677E-06	3.183	163	Good	--	4.028E-05	2.745	11	Poor	
<b>North Fork of the Middle Fork American River</b>											
NFMF2.3	2007	2.737E-06	3.275	72	Good	--	NA	NA	0	NA	NA
	2008	8.779E-06	3.035	49	Poor	Project Wide RBT <sup>4</sup>	NA	NA	0	NA	NA
<b>North Fork American River</b>											
NF18.4	2007	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
NF31.3	2007	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide RBT <sup>4</sup>	Snorkel Only <sup>3</sup>	Snorkel Only <sup>3</sup>	0	NA	Project Wide BNT <sup>4</sup>
NF53.7	2007	9.137E-06	0.000	21	Good	--	NA	NA	0	NA	NA
	2008	4.458E-06	3.167	17	Poor	Project Wide RBT <sup>4</sup>	NA	NA	0	NA	NA
<b>Project Wide</b>											
Project Wide	2007	4.260E-06	3.187	2299	Good	NA	2.408E-06	3.295	280	Good	NA
	2008	4.243E-06	3.194	1888	Good	NA	1.292E-05	2.967	119	Good	NA

<sup>1</sup>W=Weight(g); a=Constant; L=Length(mm); b=Constant

<sup>2</sup>Refers to the range of fish in the regression equation; Good= Wide range of fish sizes in regression; Poor= Narrow range of fish sizes in regression

<sup>3</sup>Refers to sites that no length to weight regression could be calculated

<sup>4</sup>Refers to the length-weight regression of all measured Rainbow Trout or Brown Trout in the project (RBT= Rainbow Trout; BNT=Brown Trout)

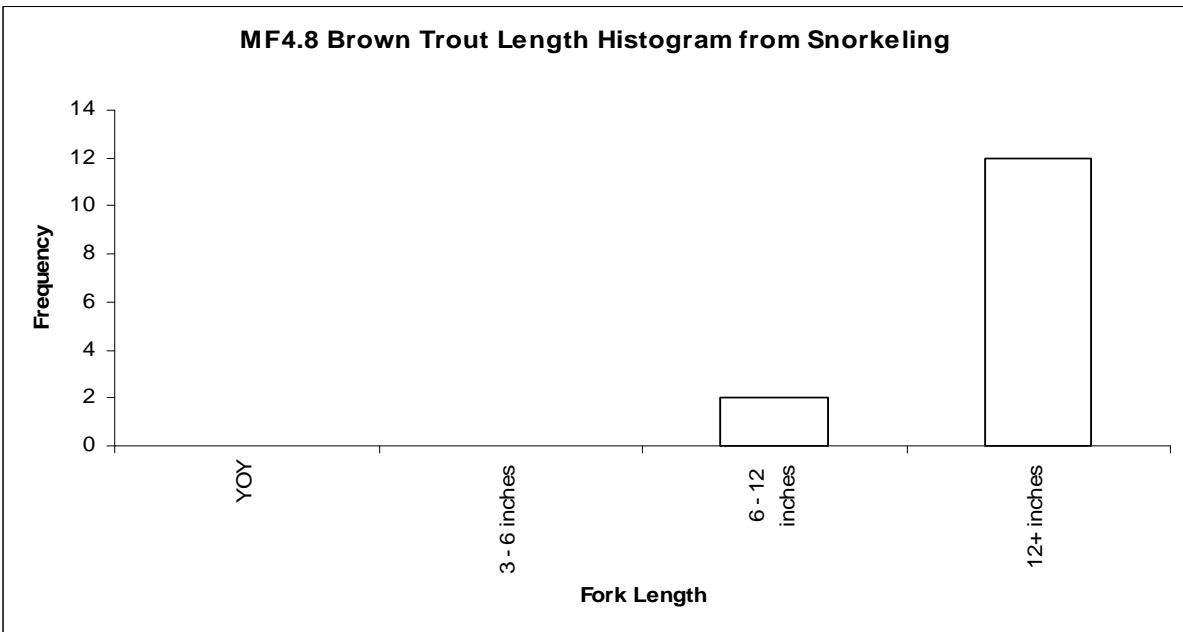
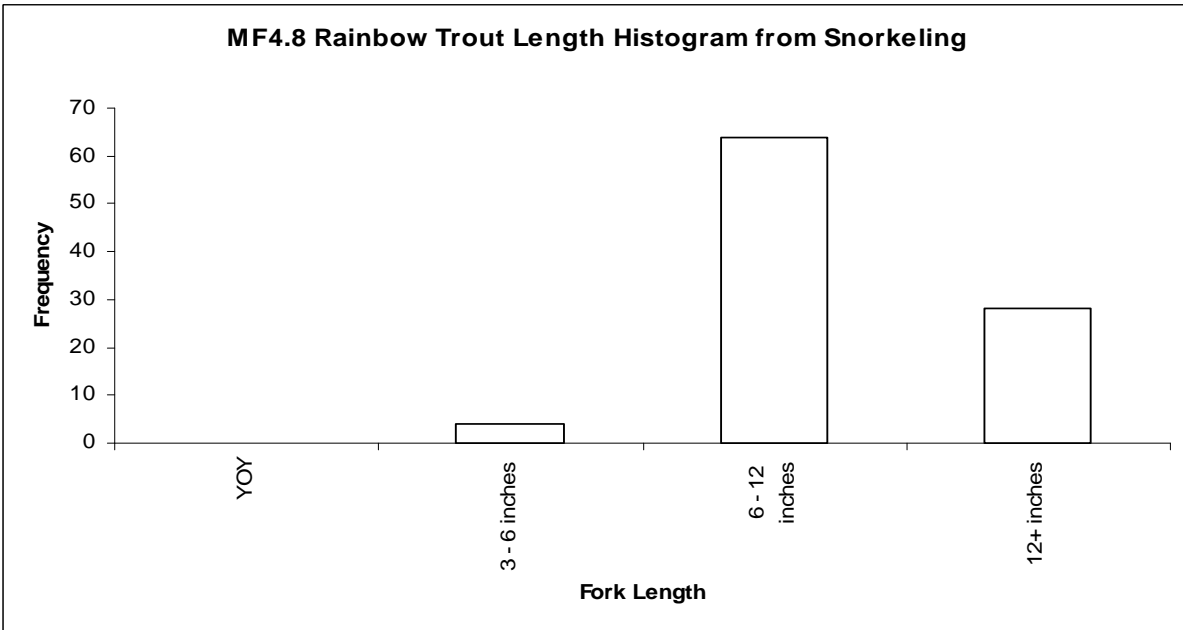
**APPENDIX E**  
**2007 Length Frequency Histograms**

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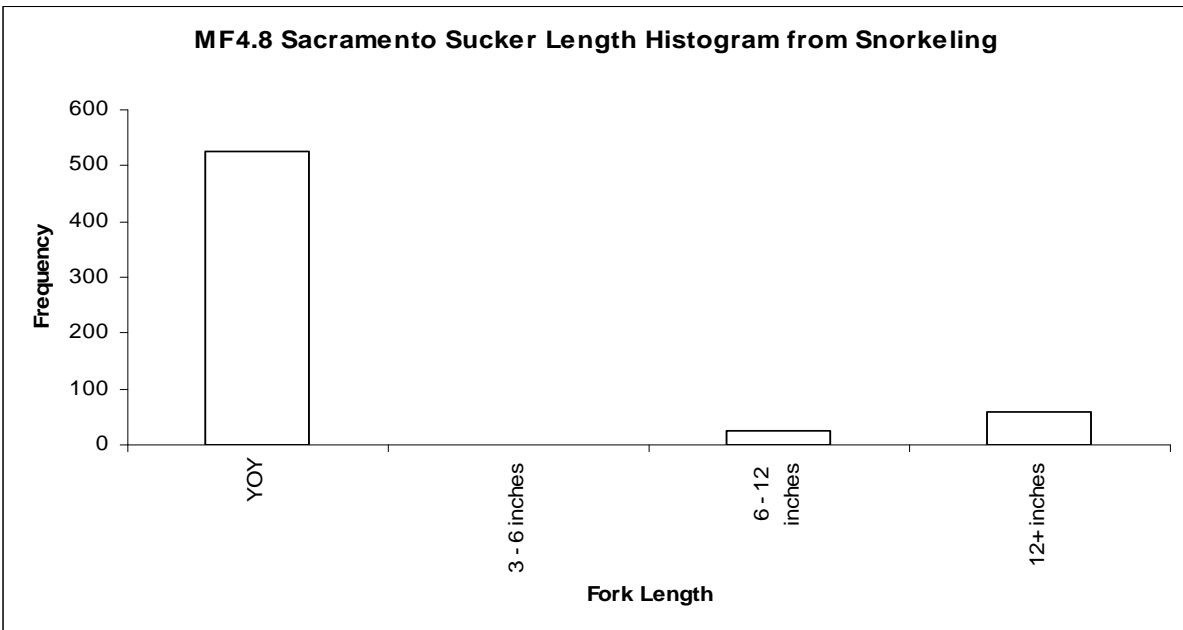
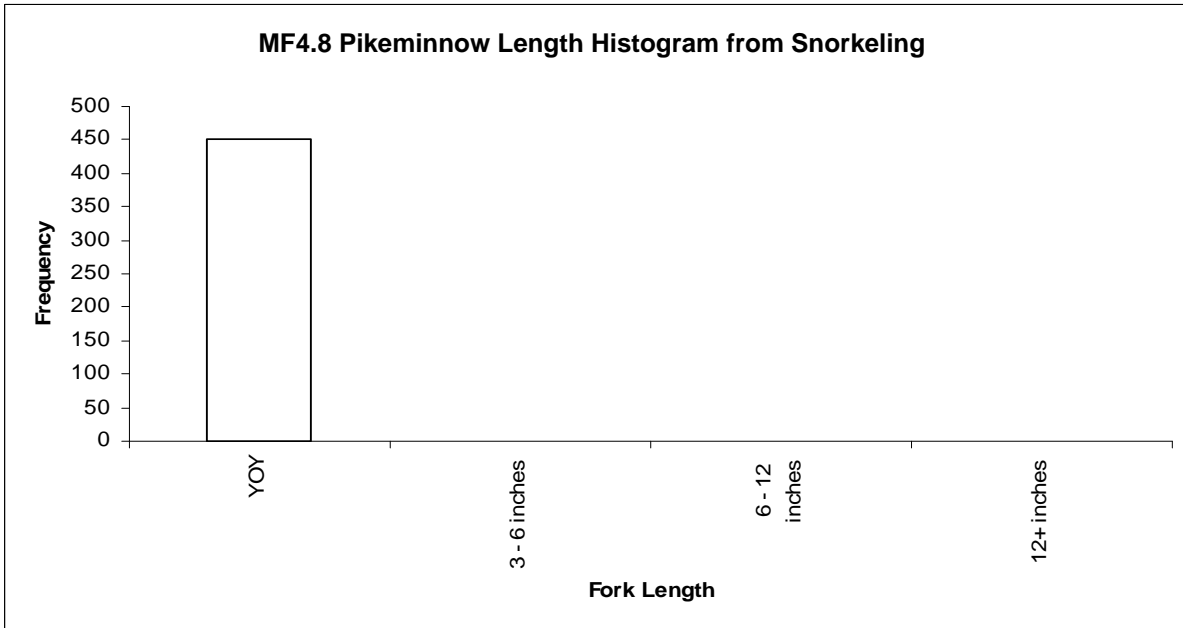
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NF31.3 Length Frequency Histograms.....	36-37
NF53.7 Length Frequency Histograms.....	38-41

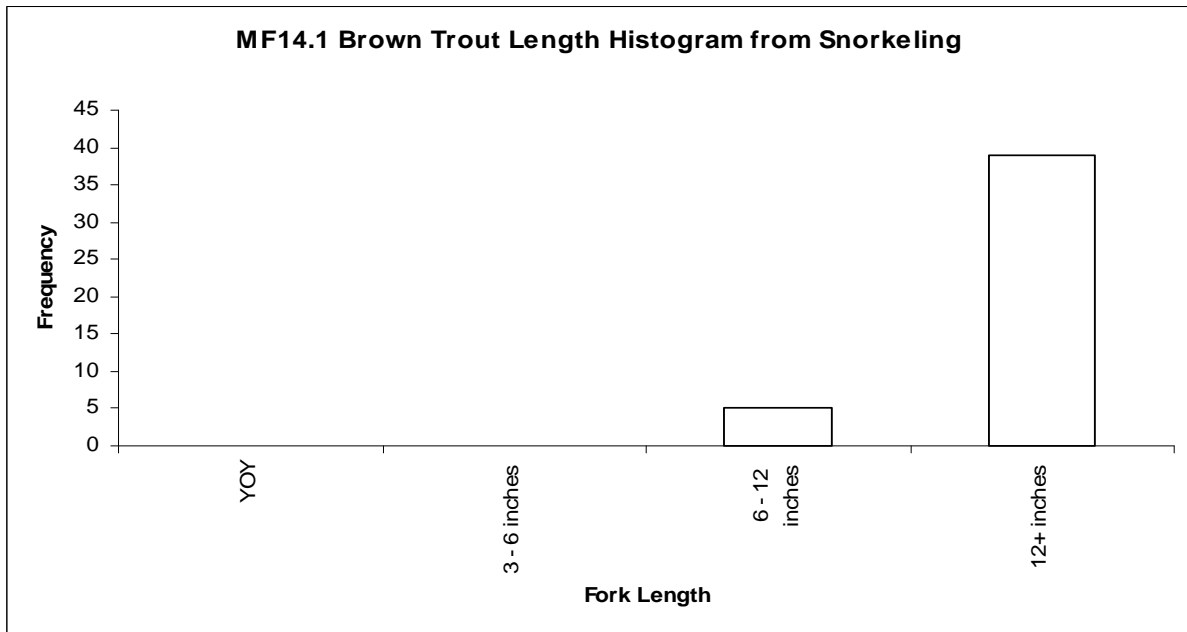
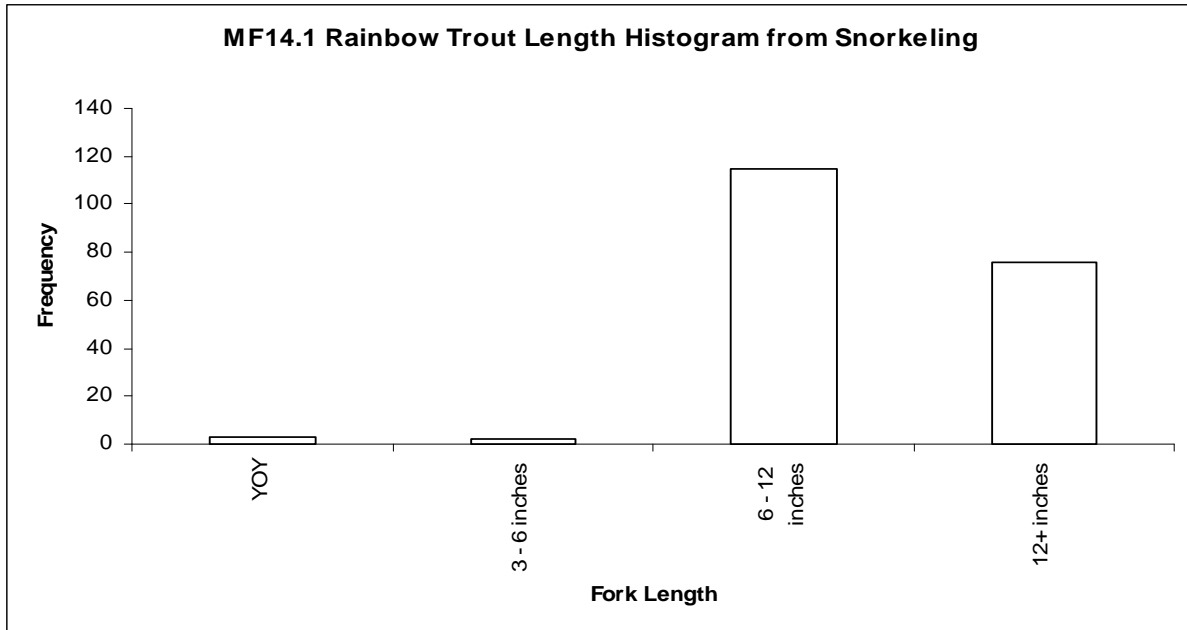
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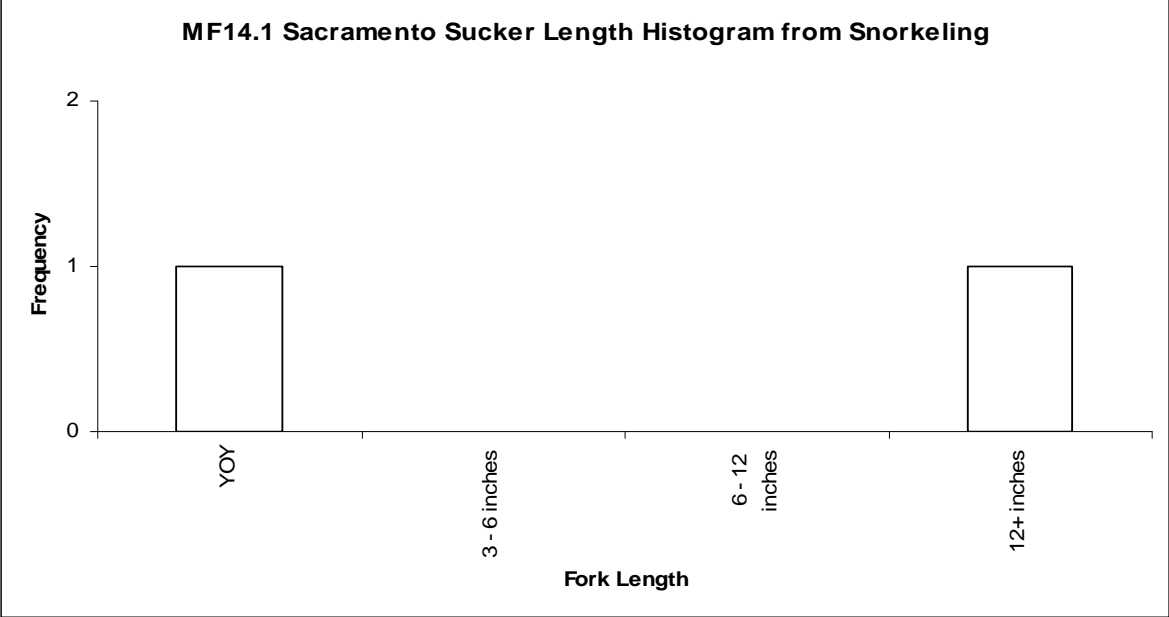
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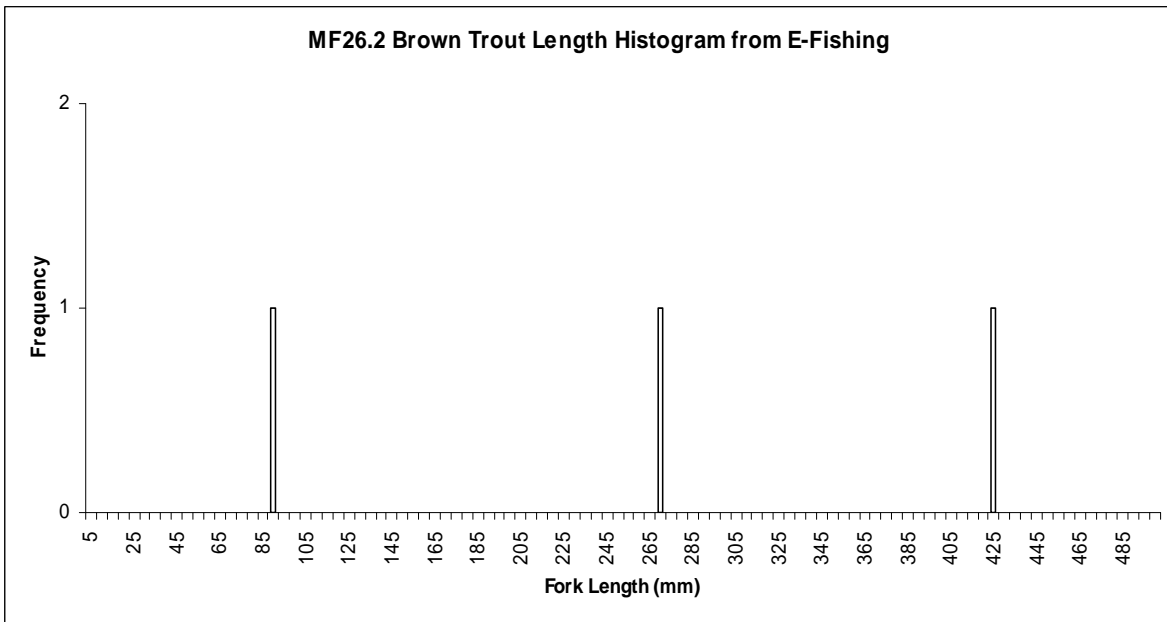
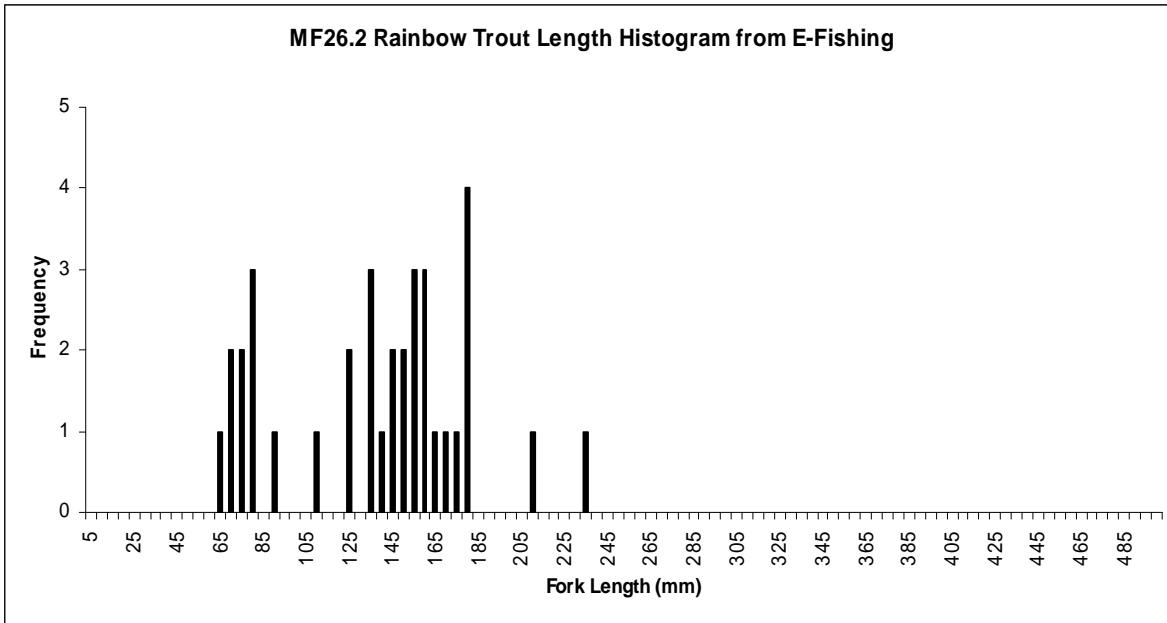
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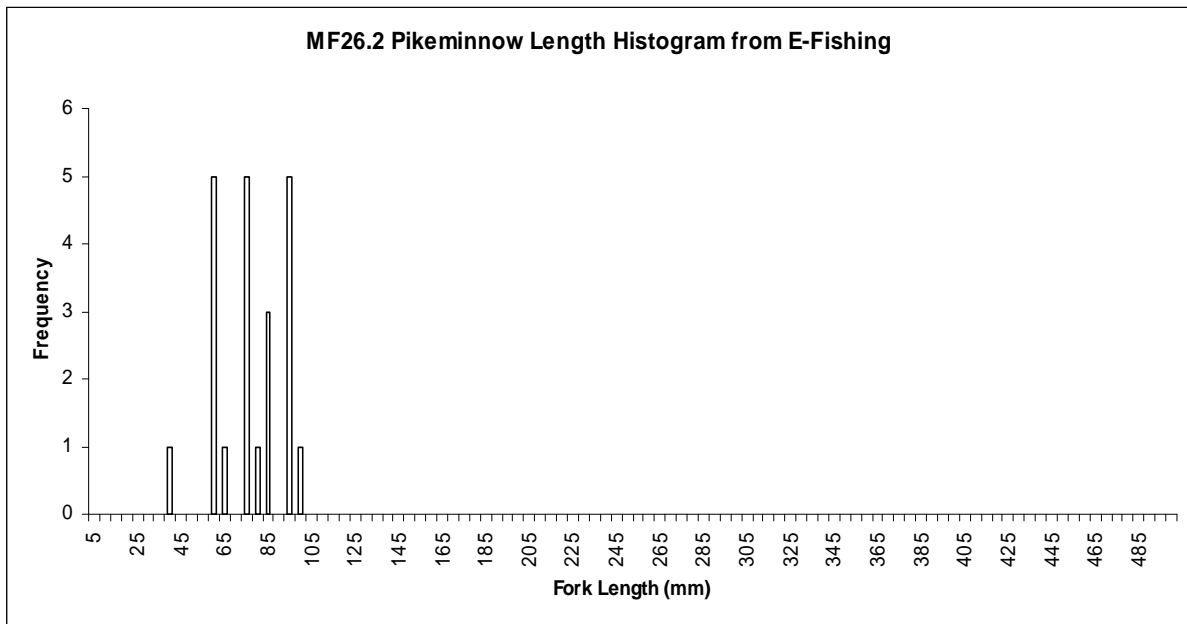
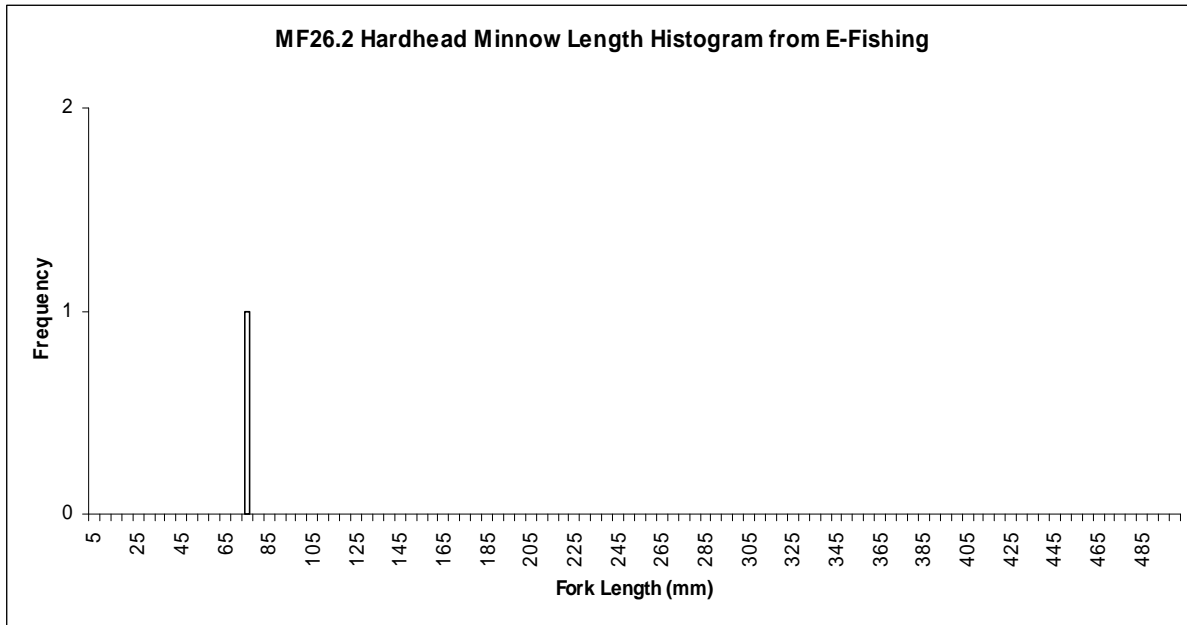
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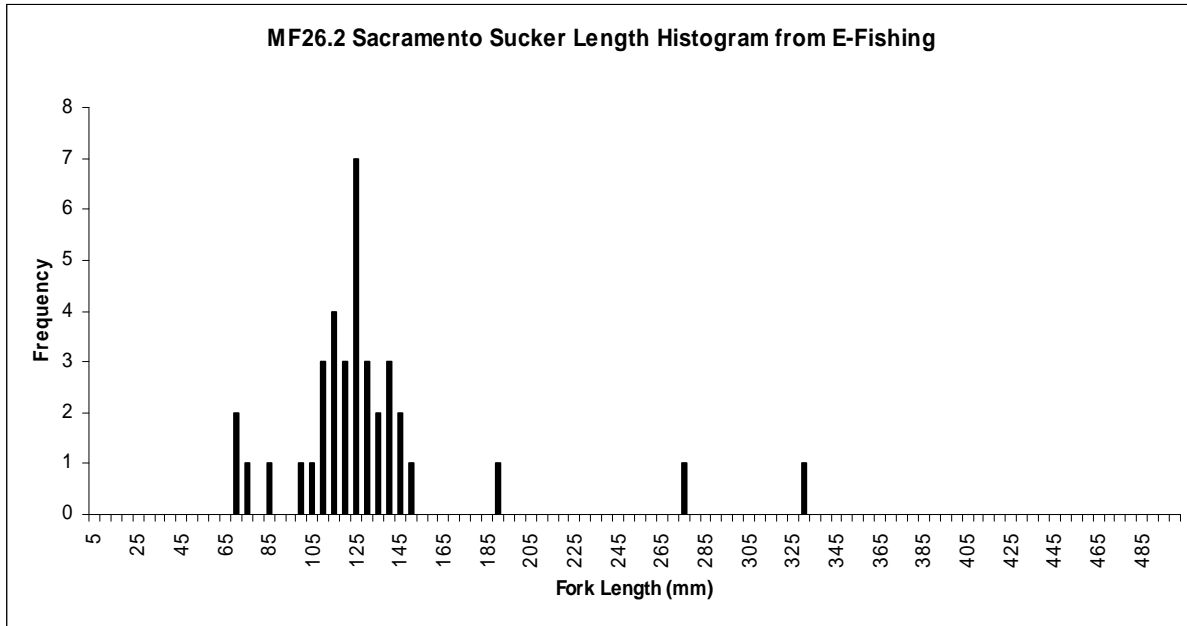
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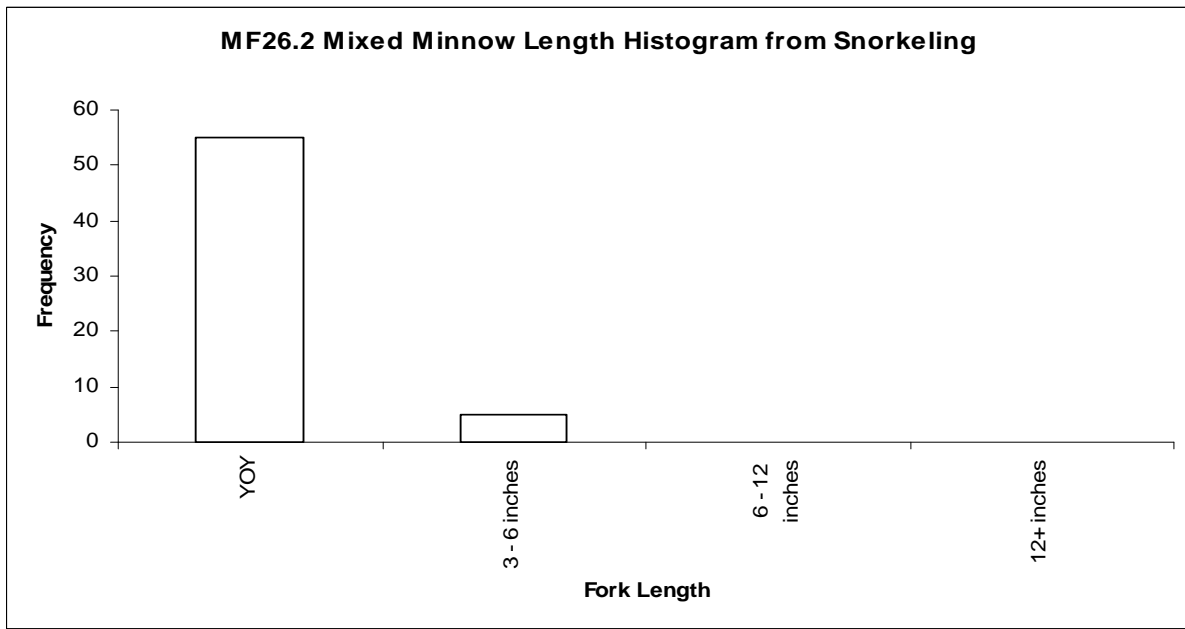
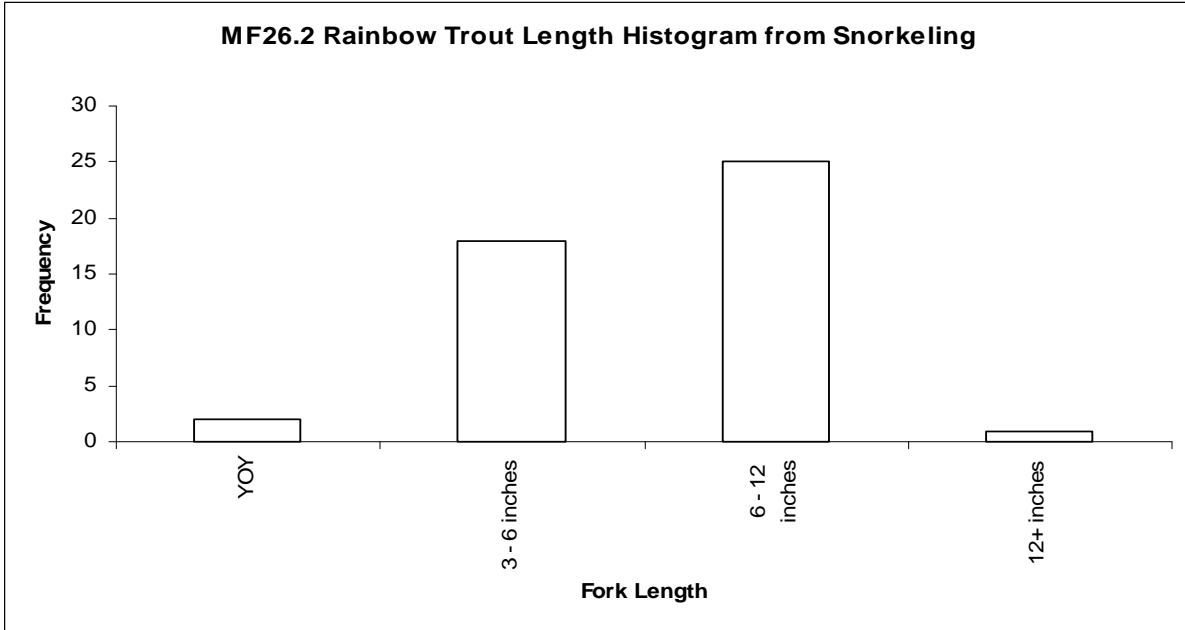
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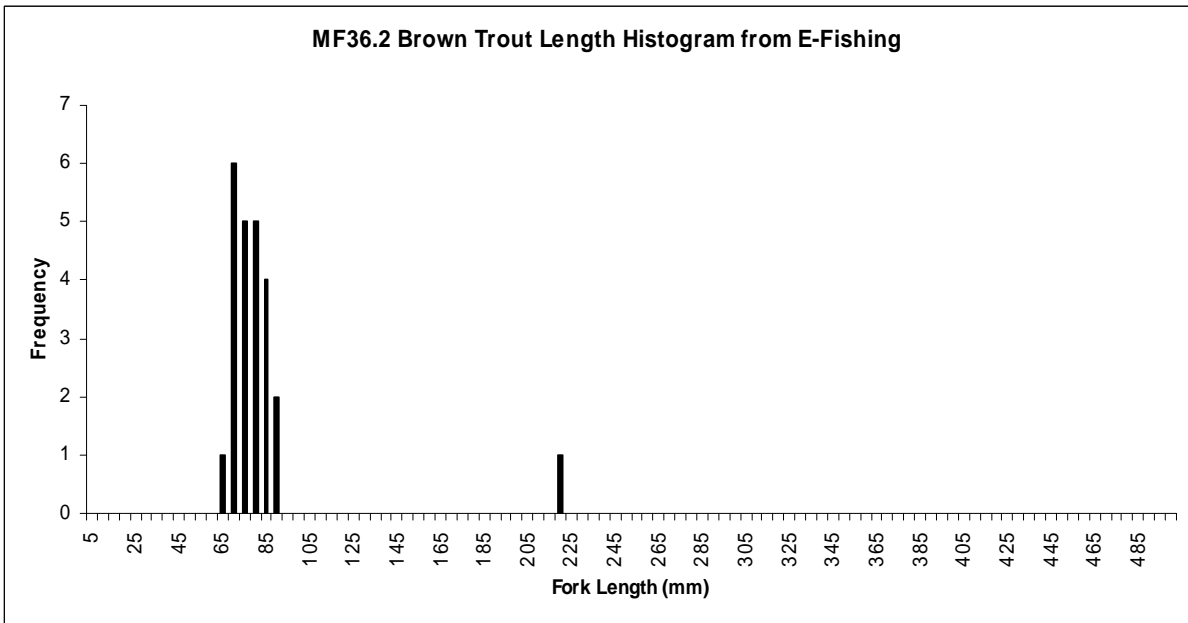
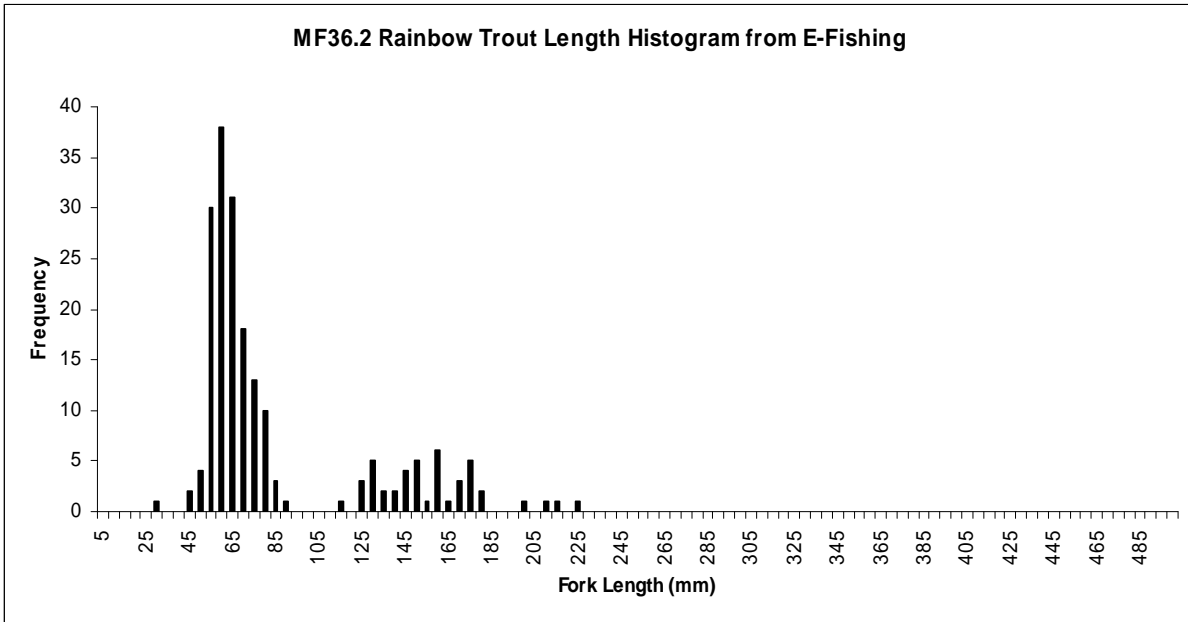
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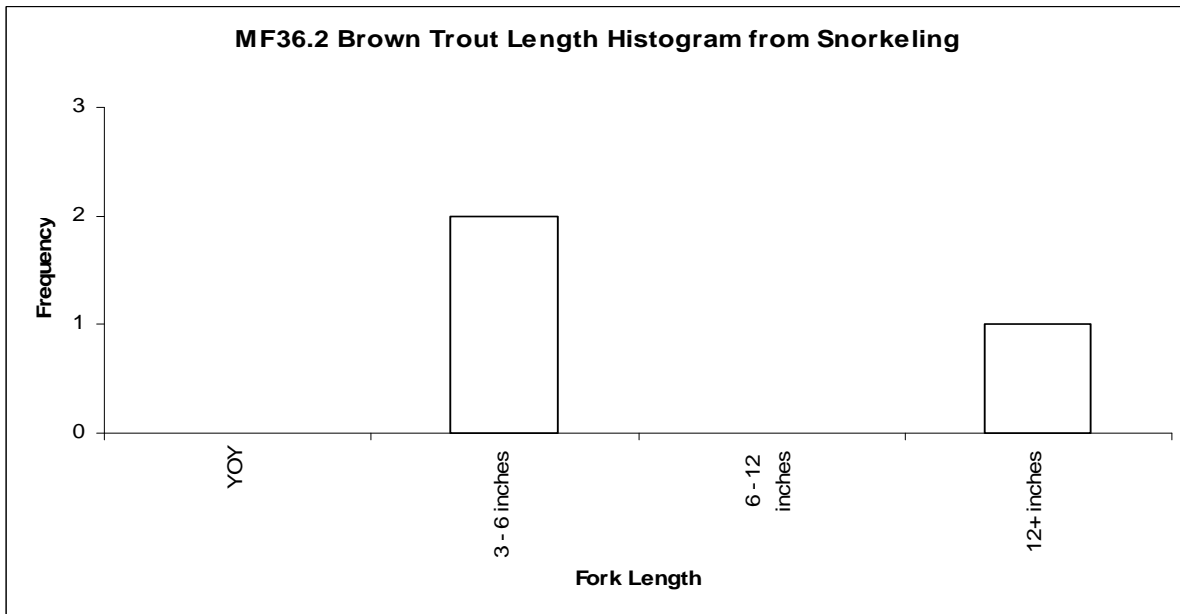
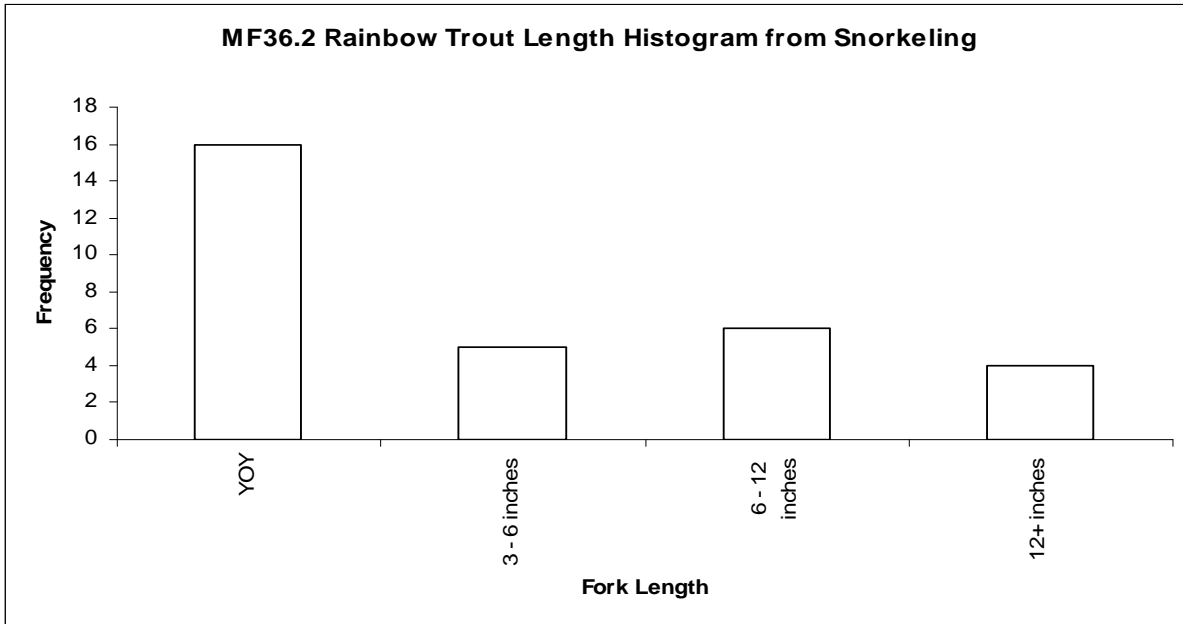
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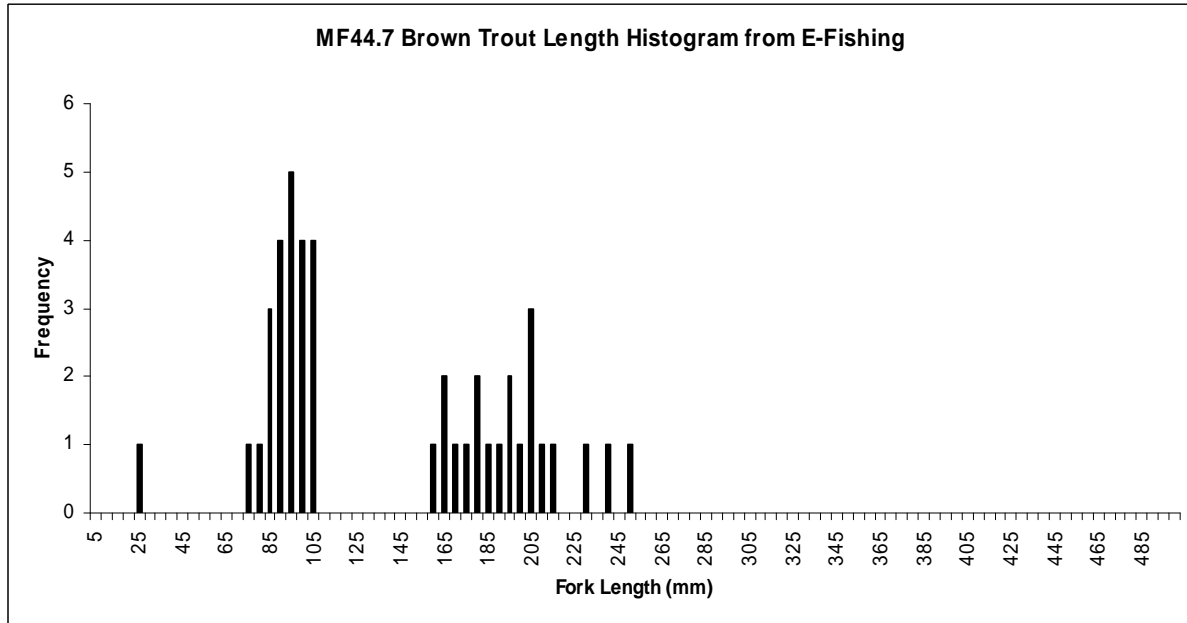
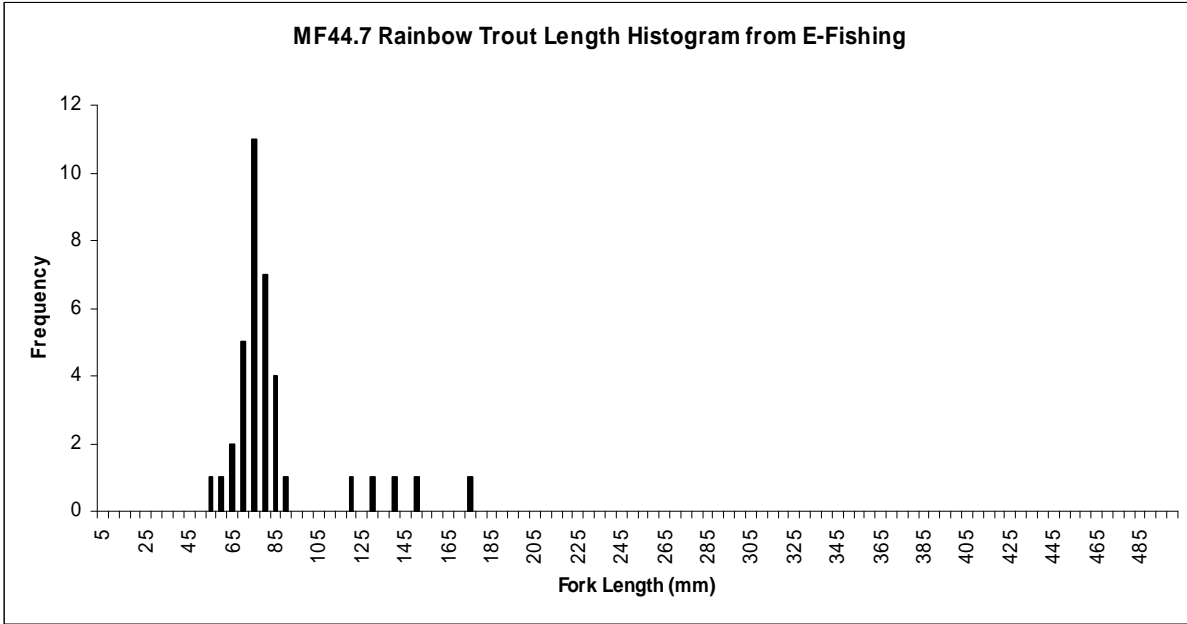
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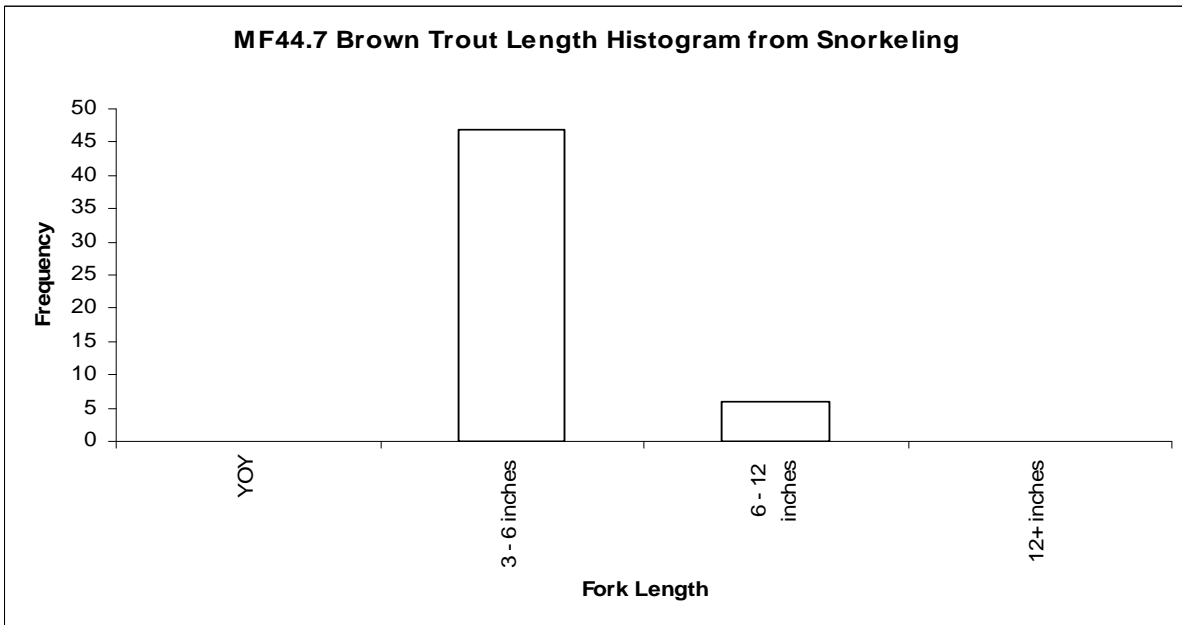
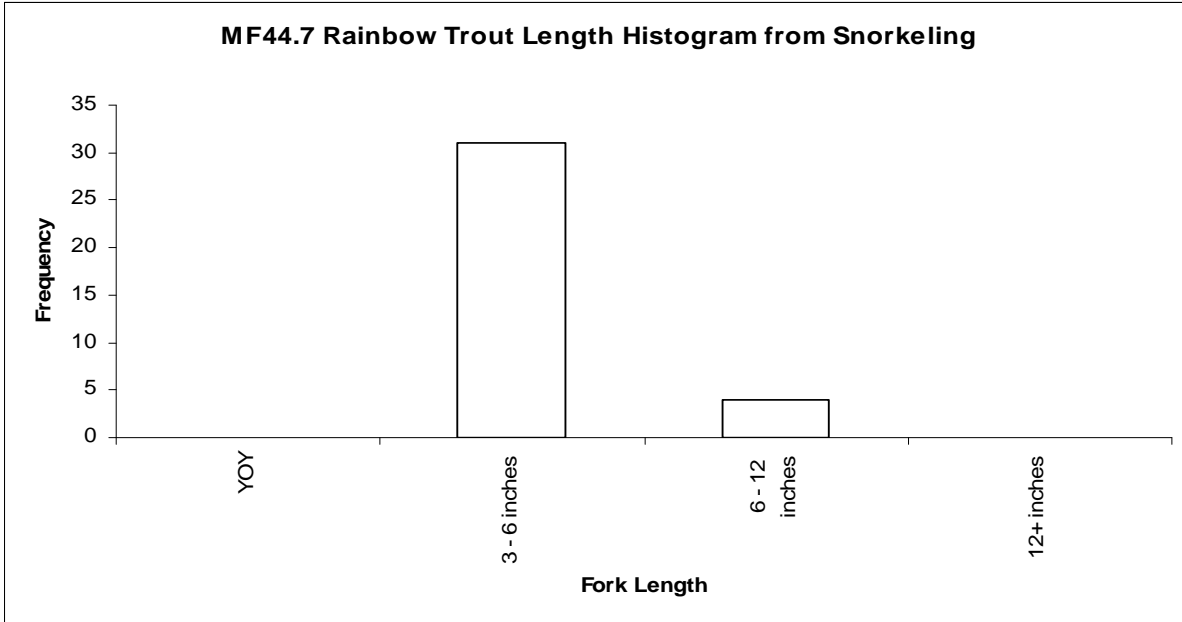
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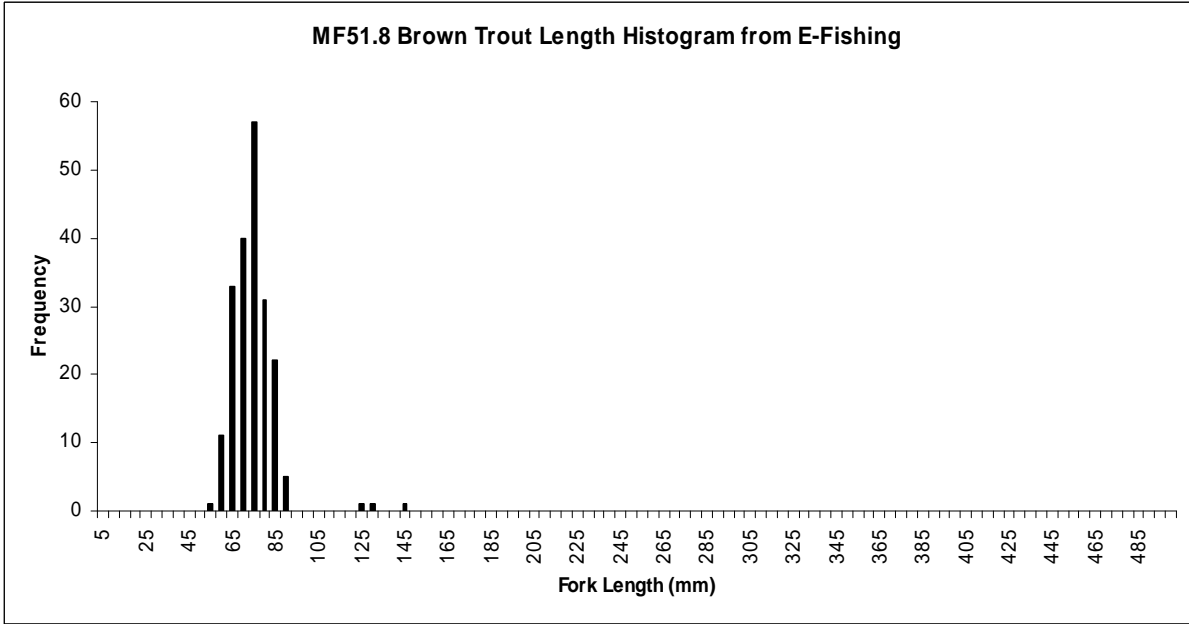
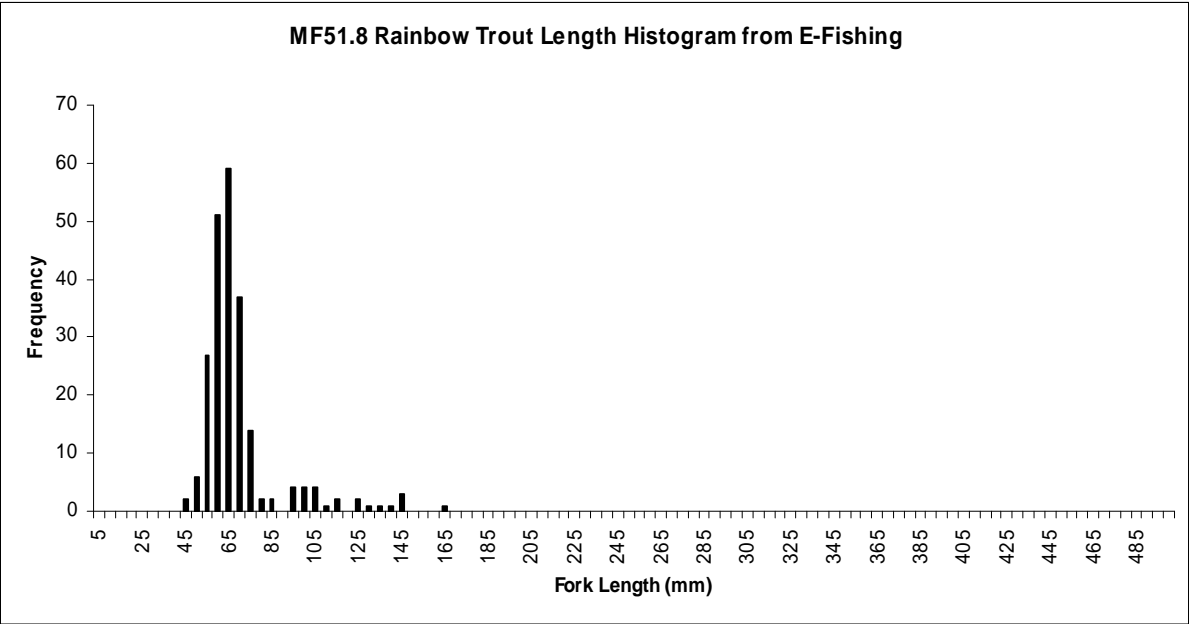
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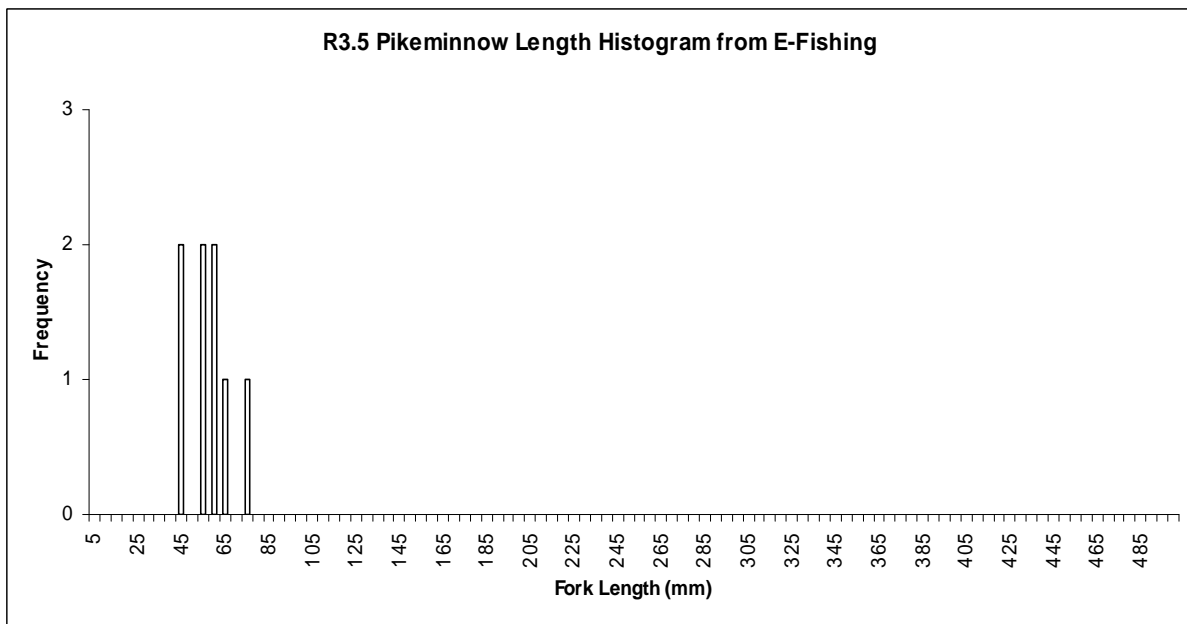
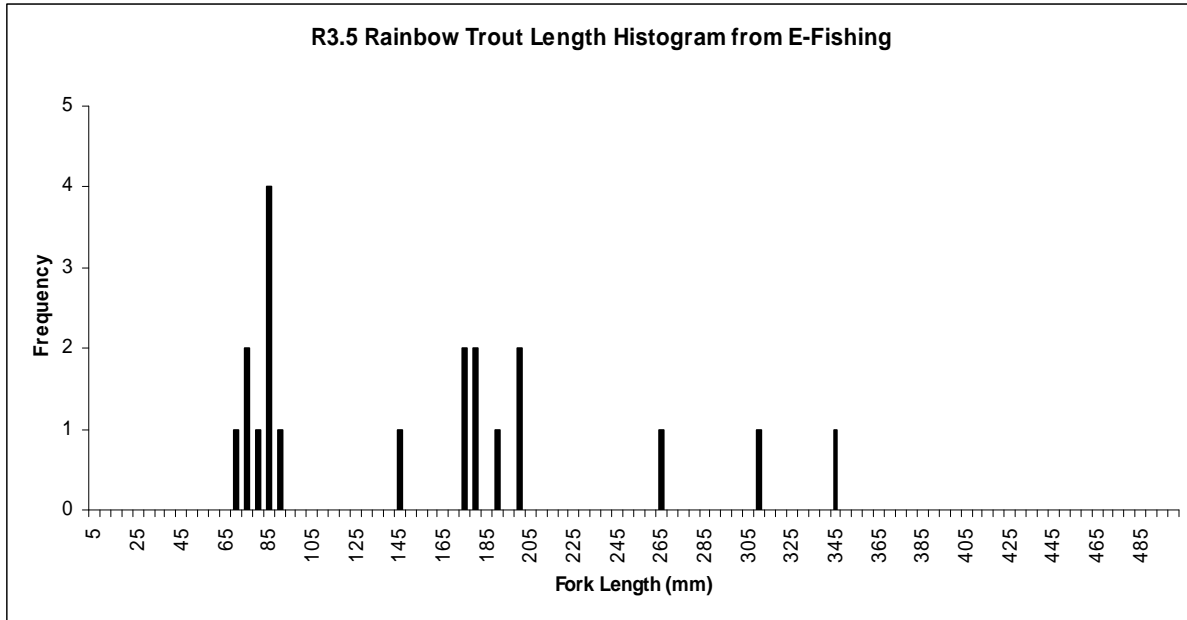
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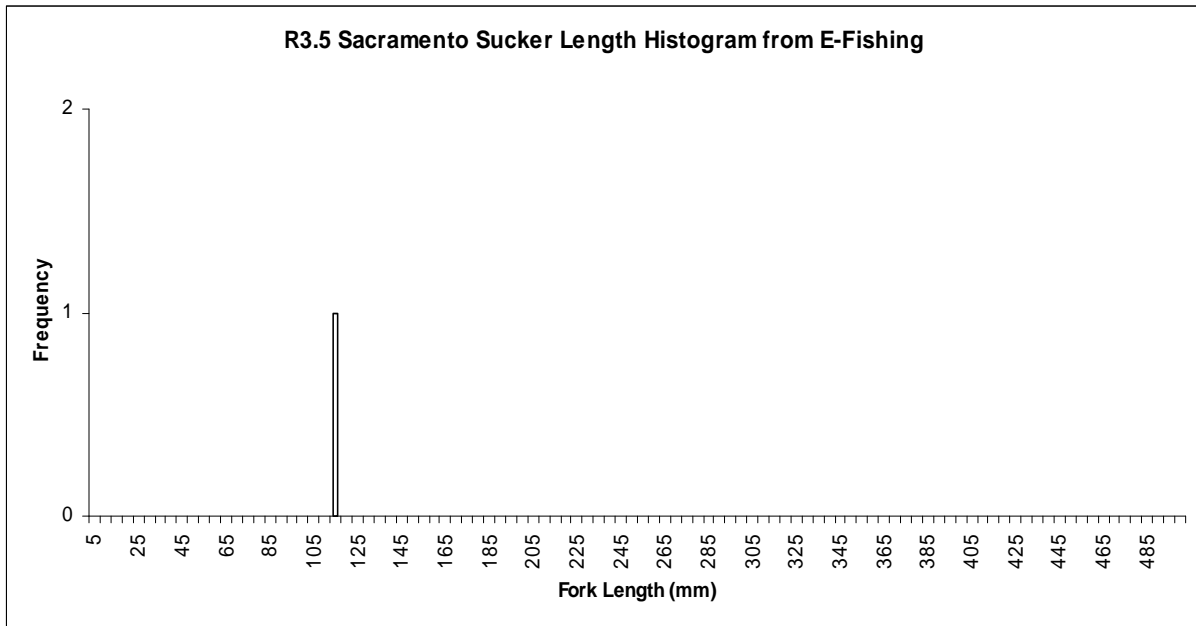
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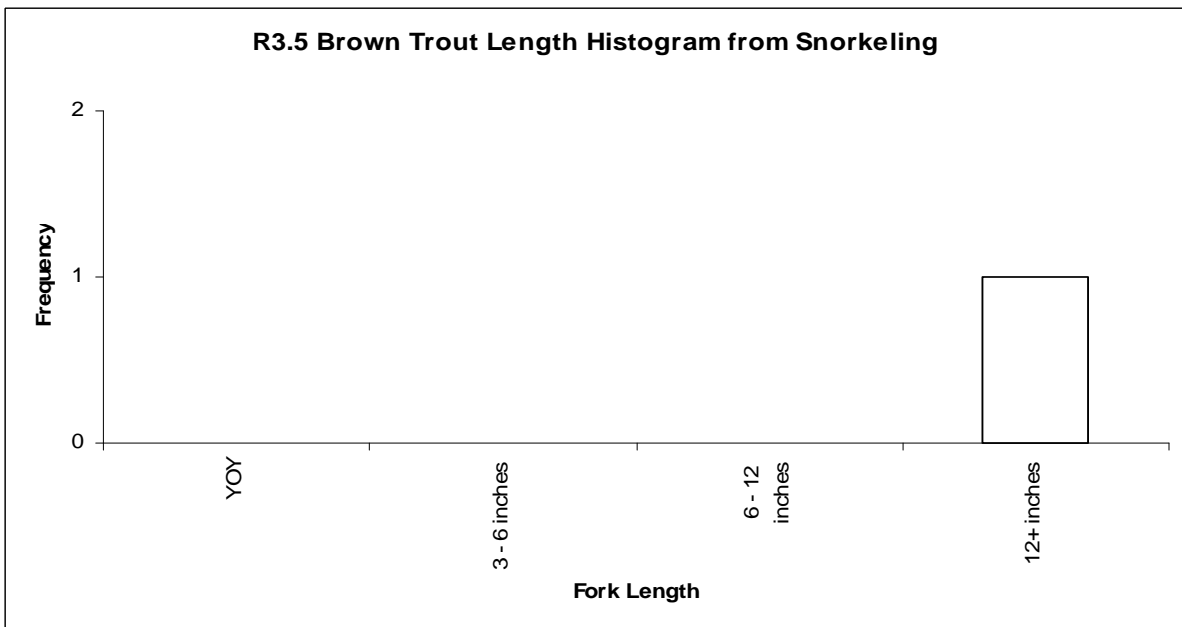
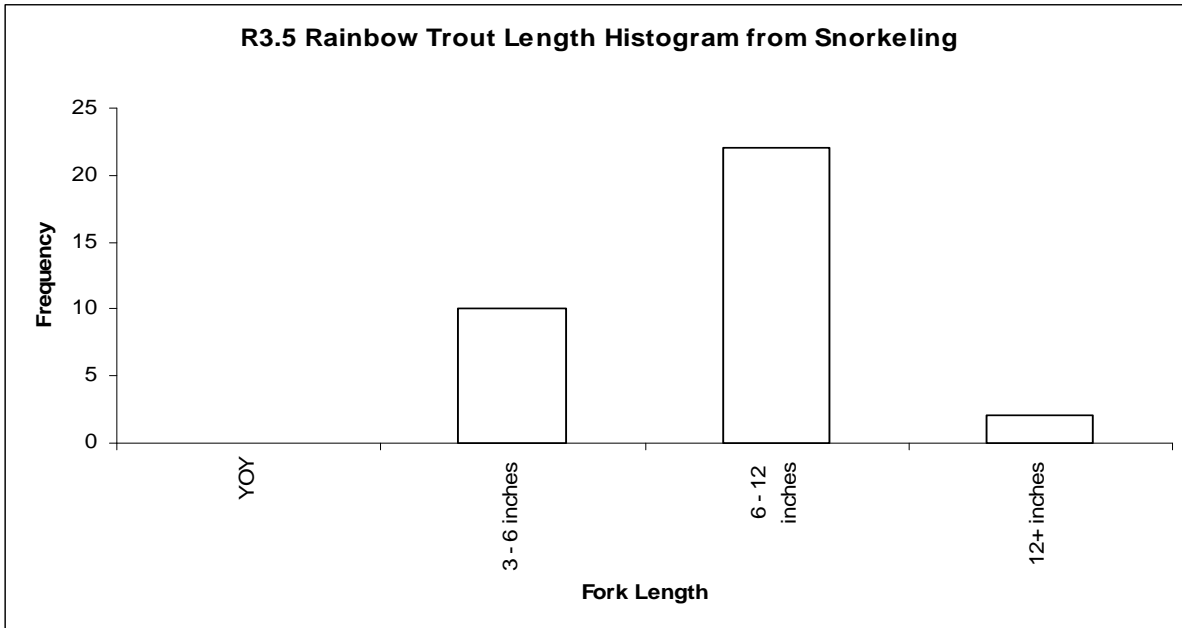
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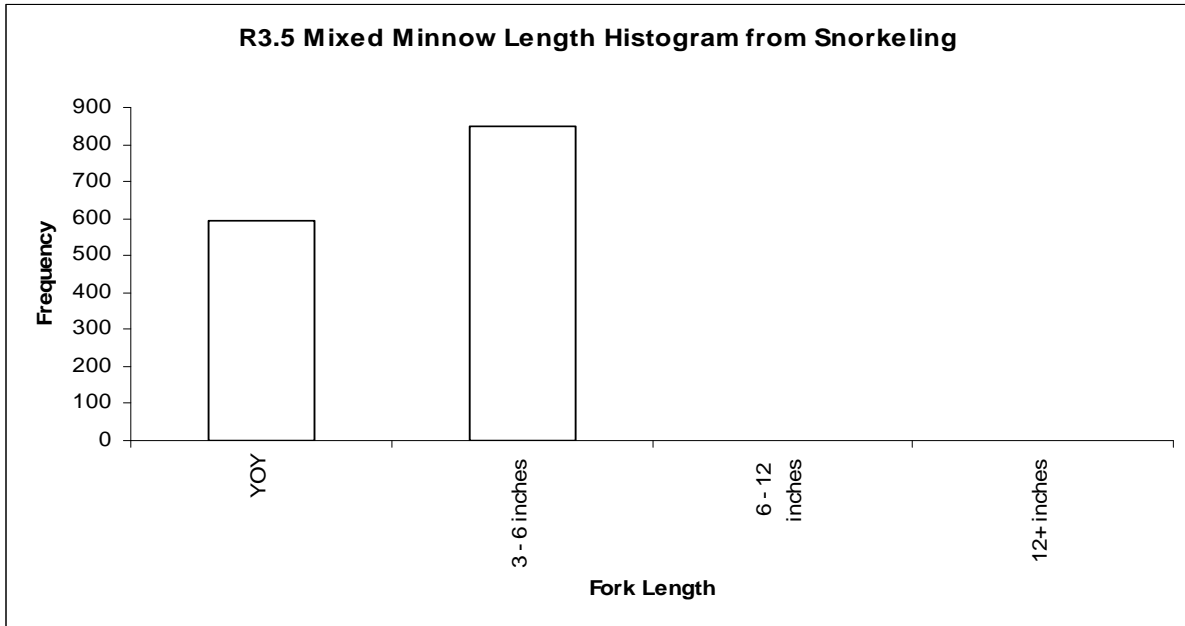
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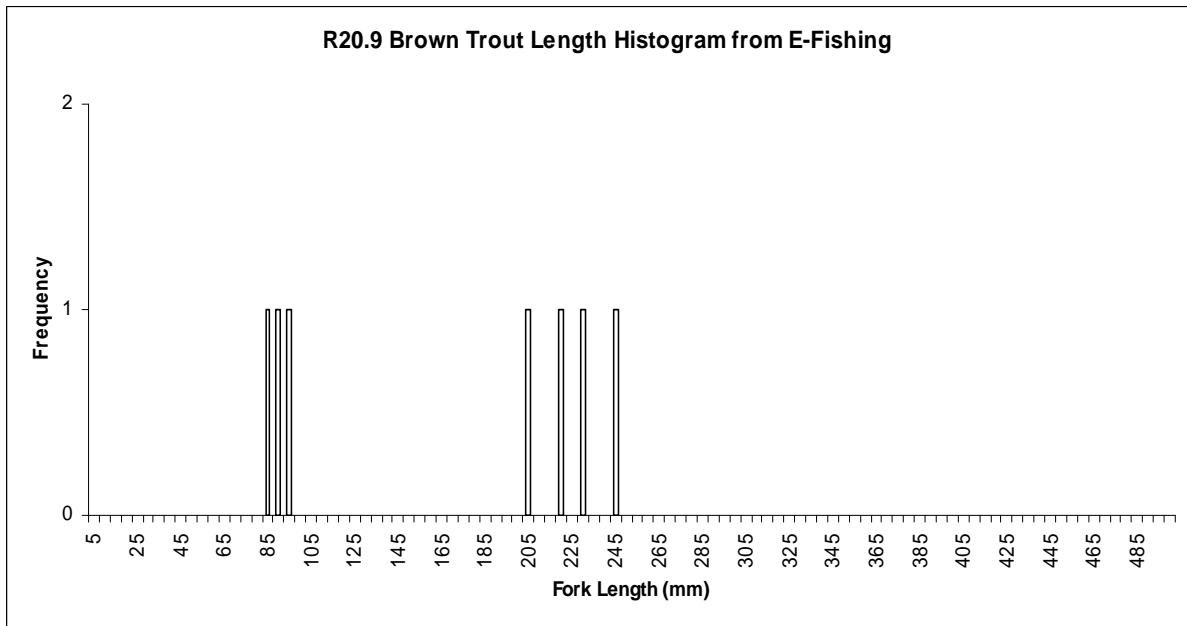
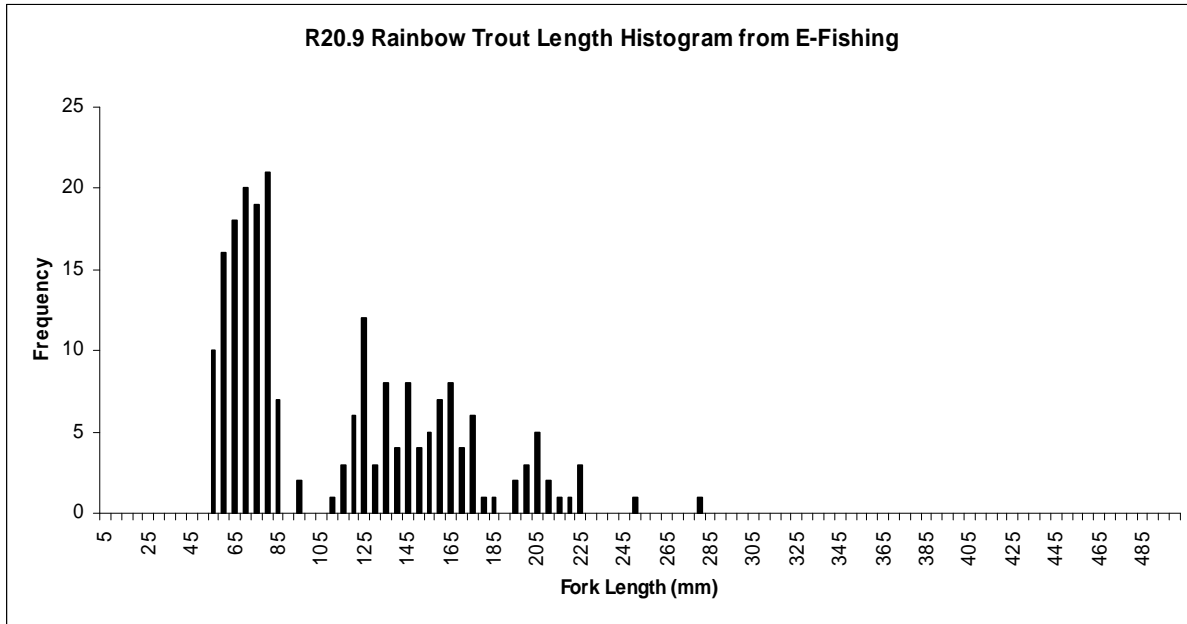
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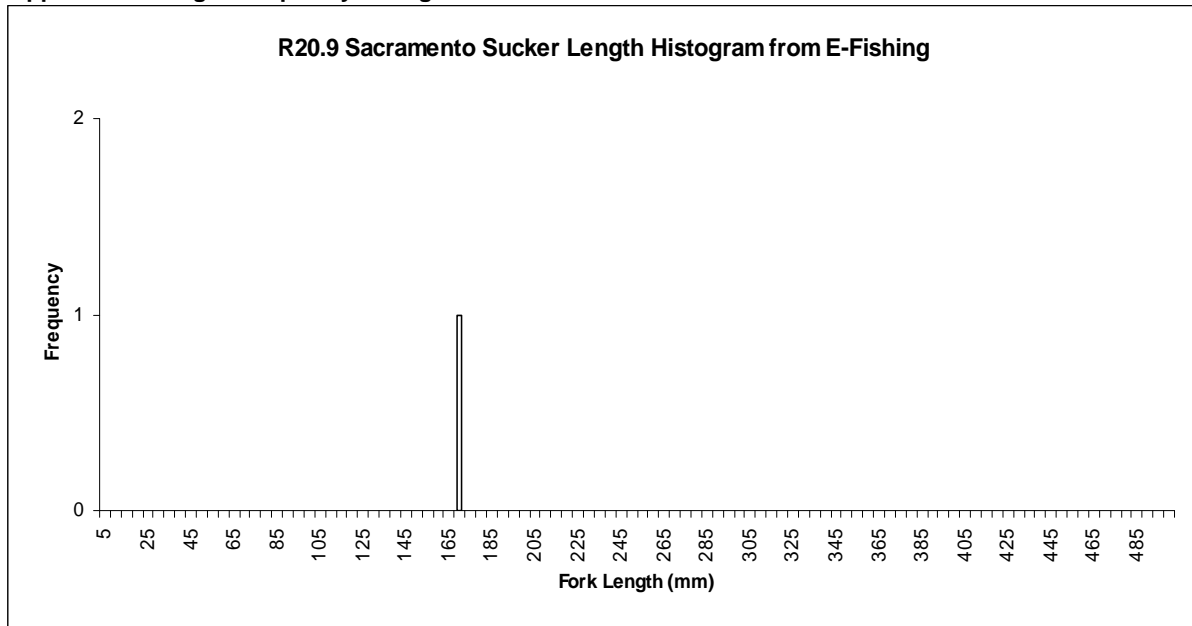
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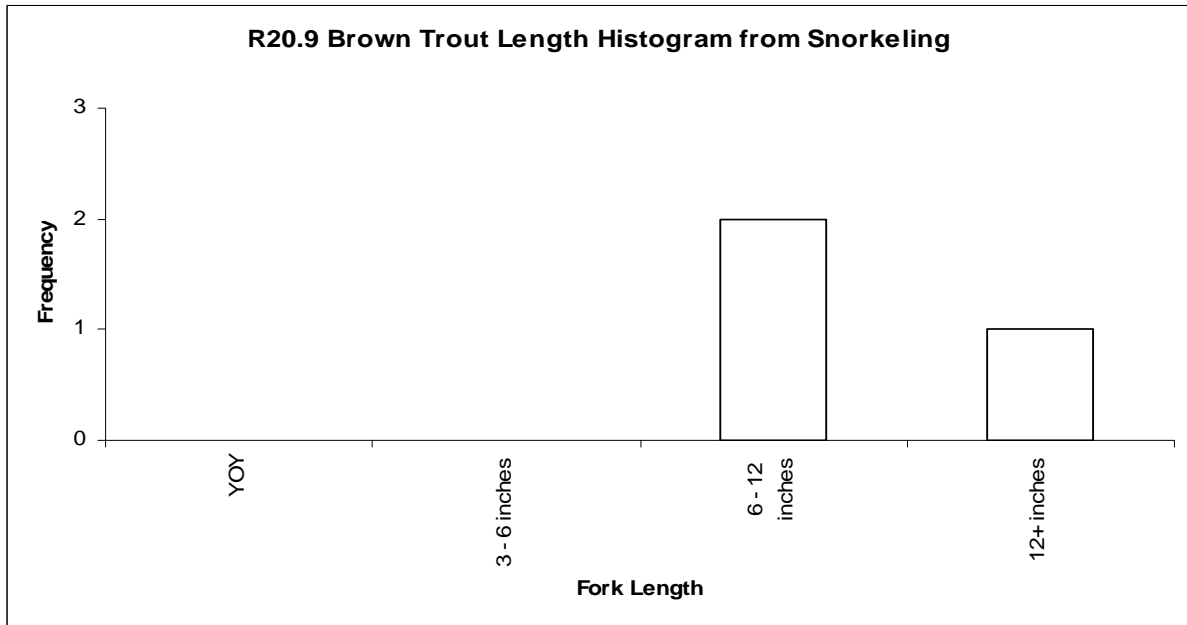
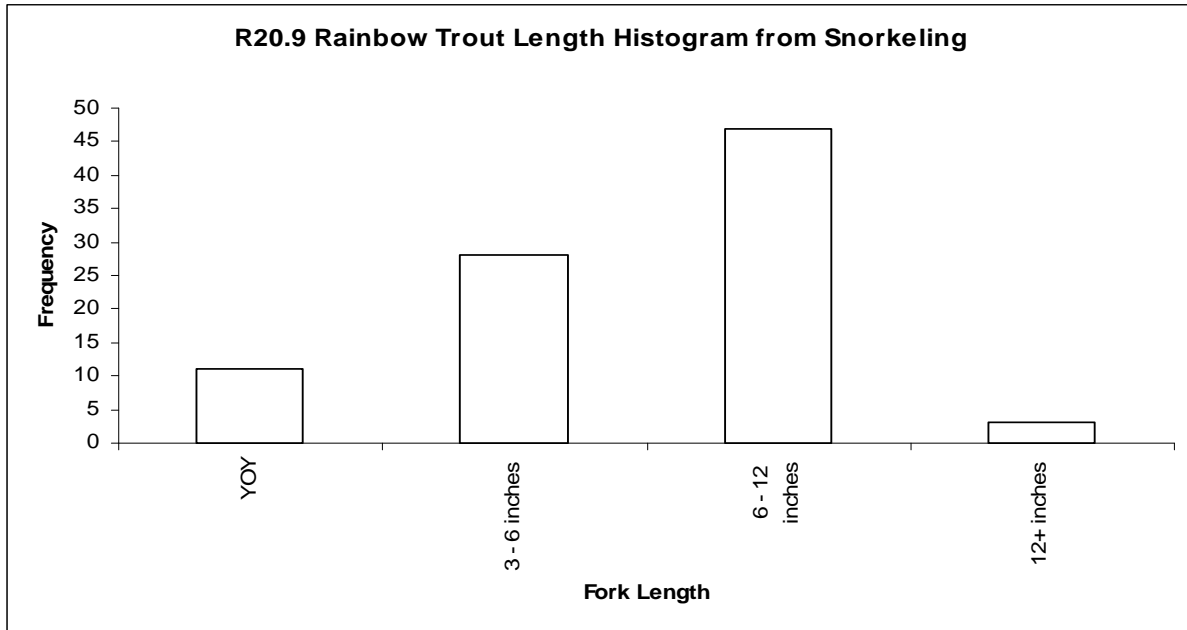
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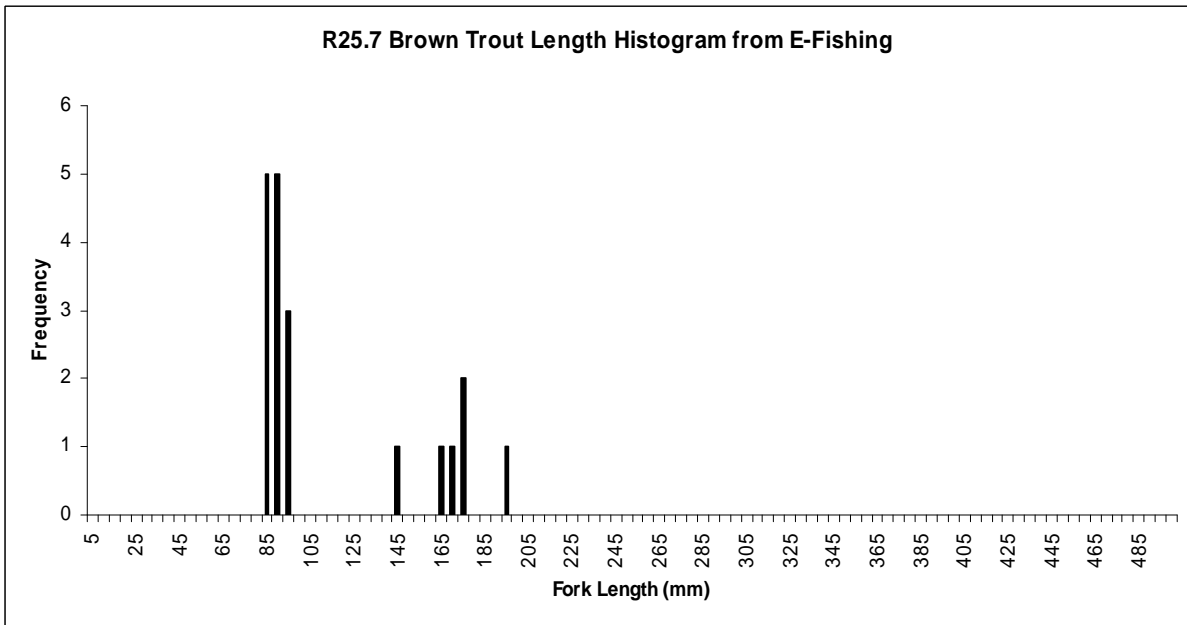
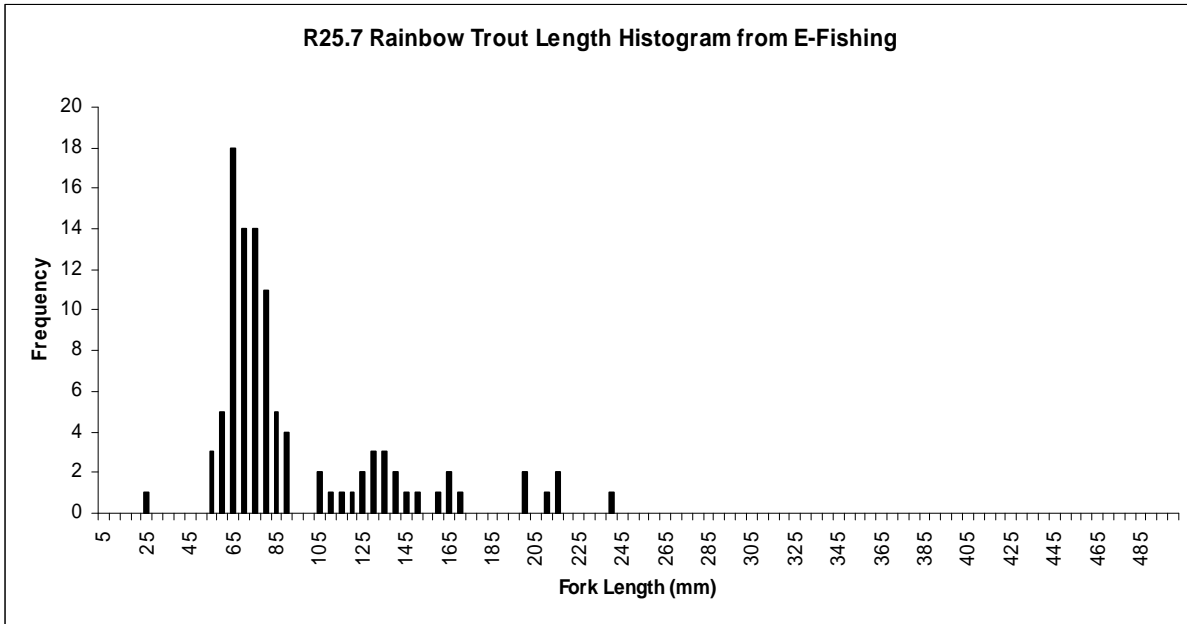
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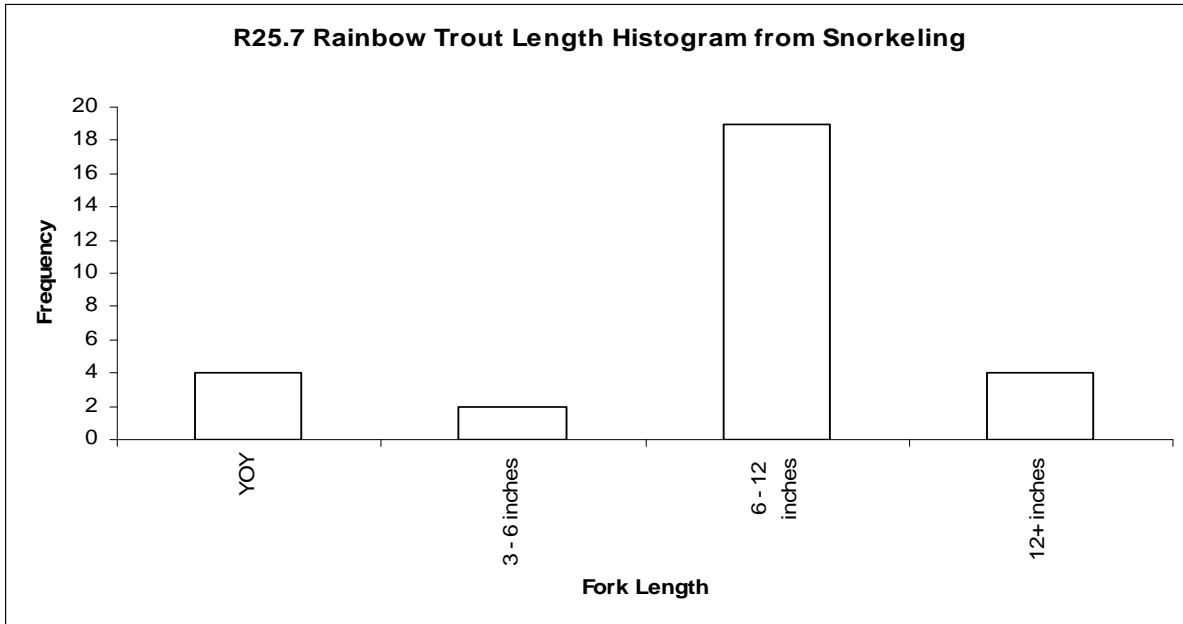
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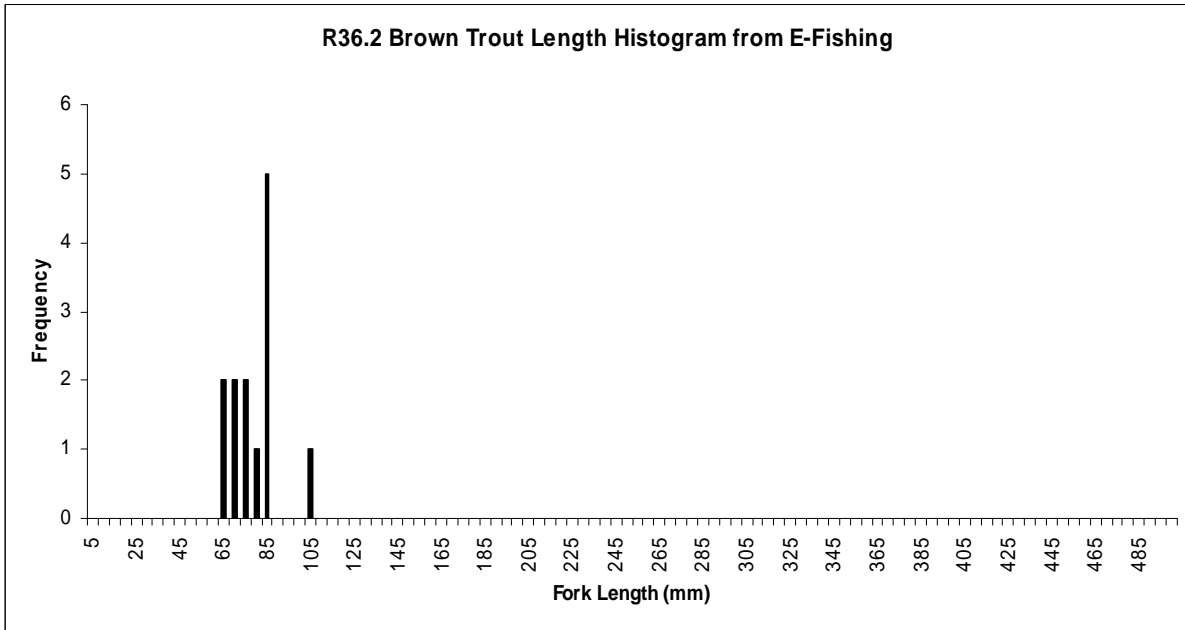
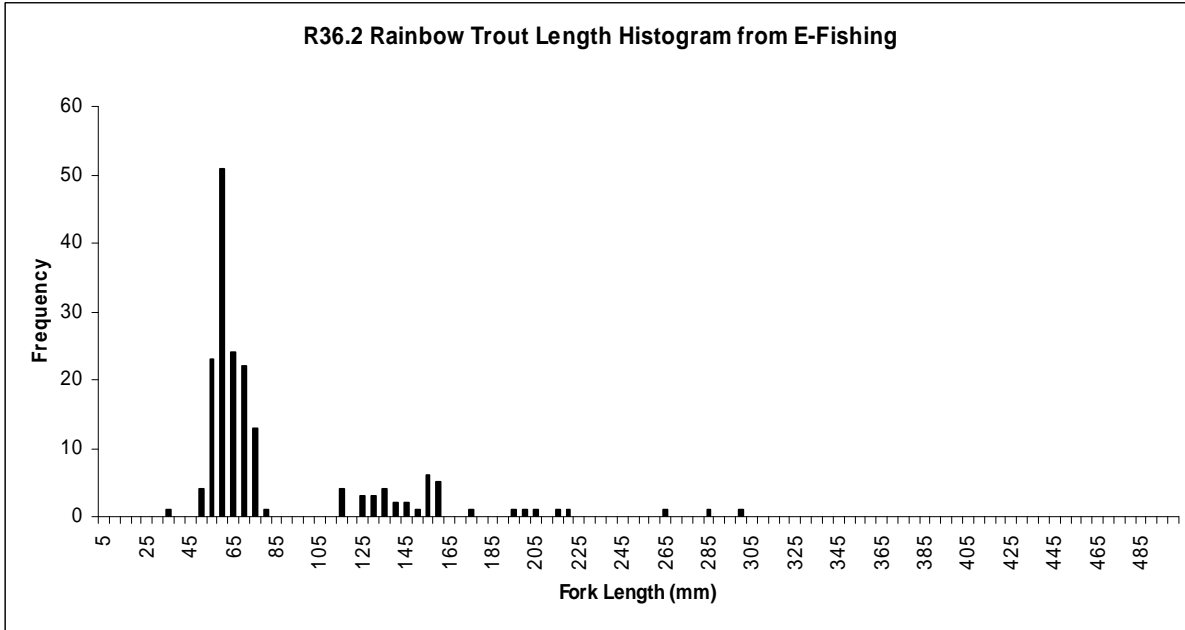
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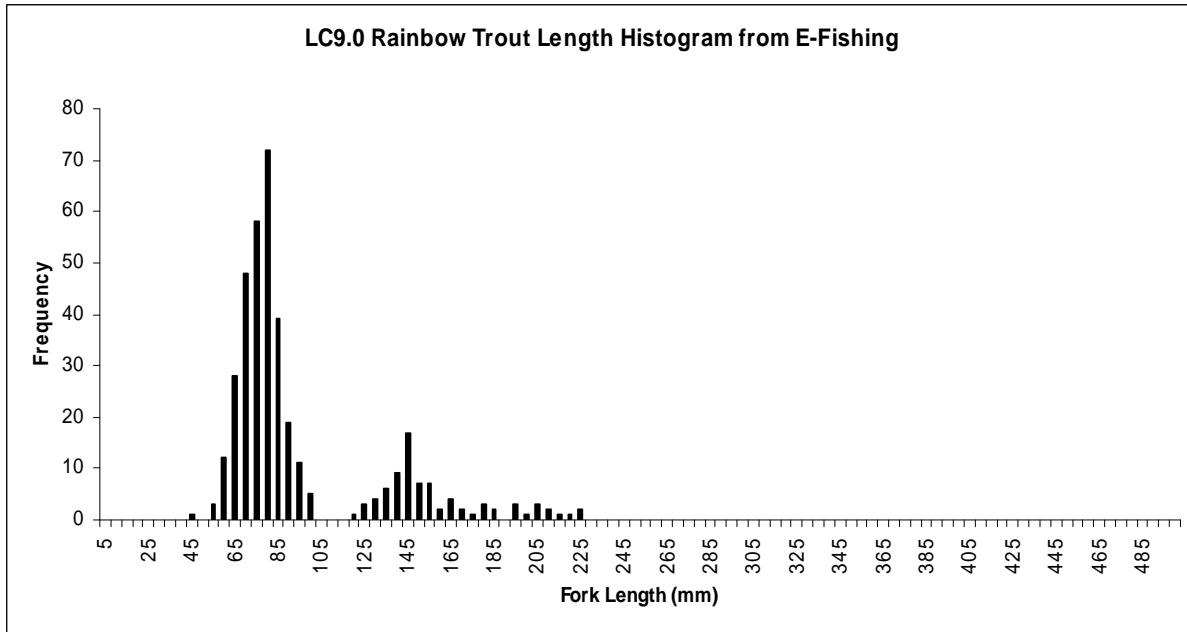
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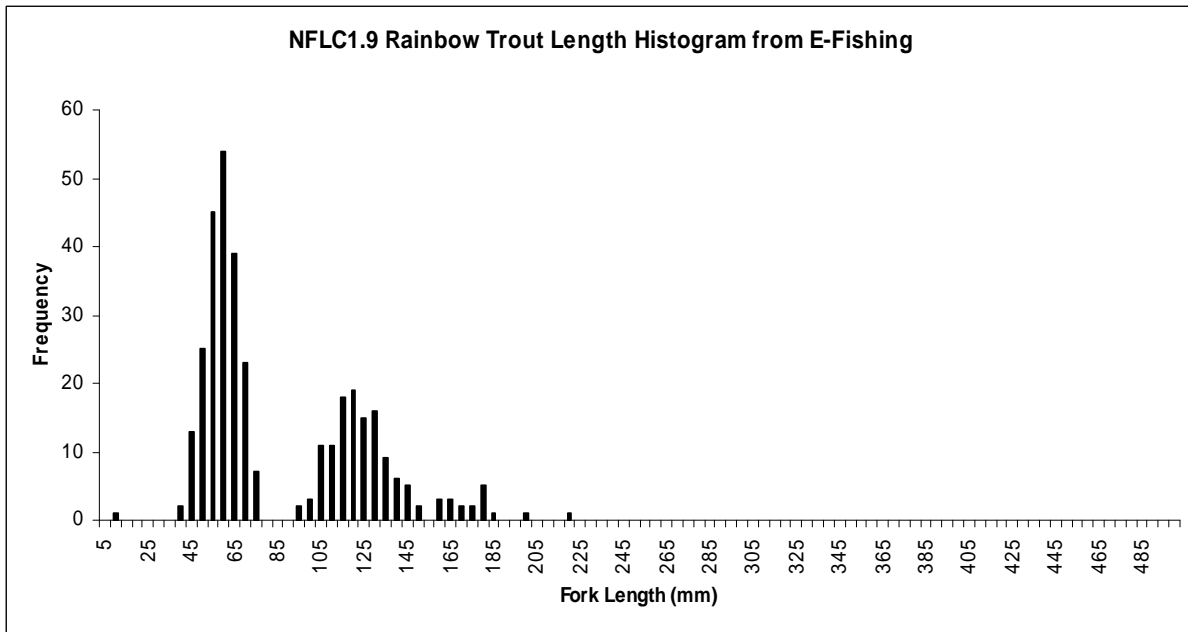
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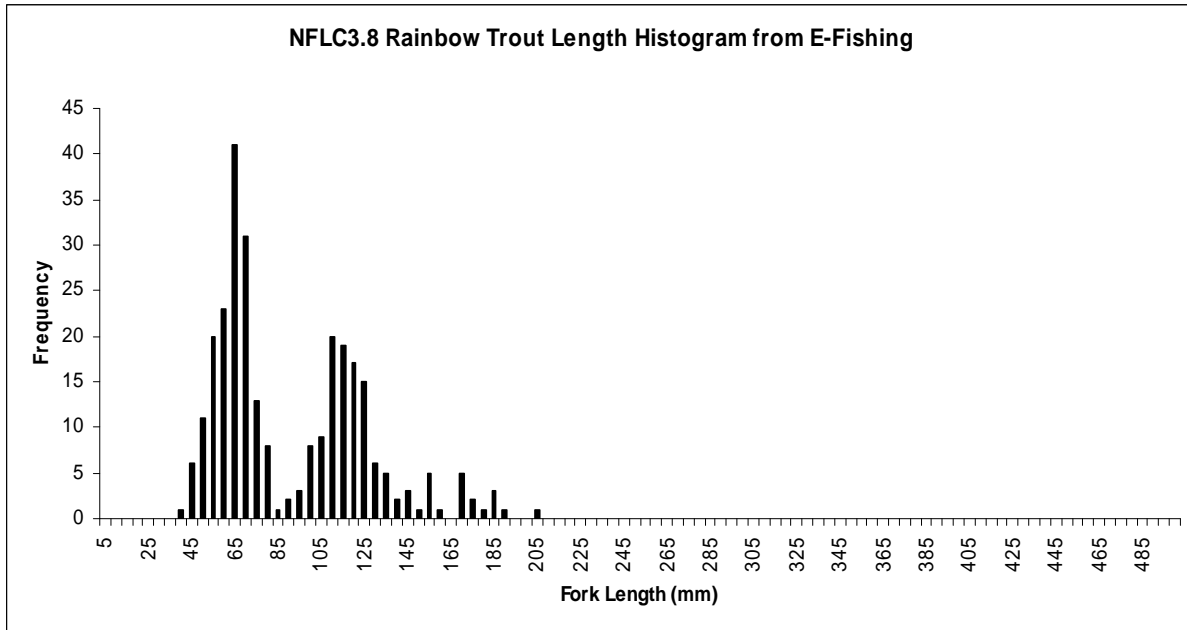
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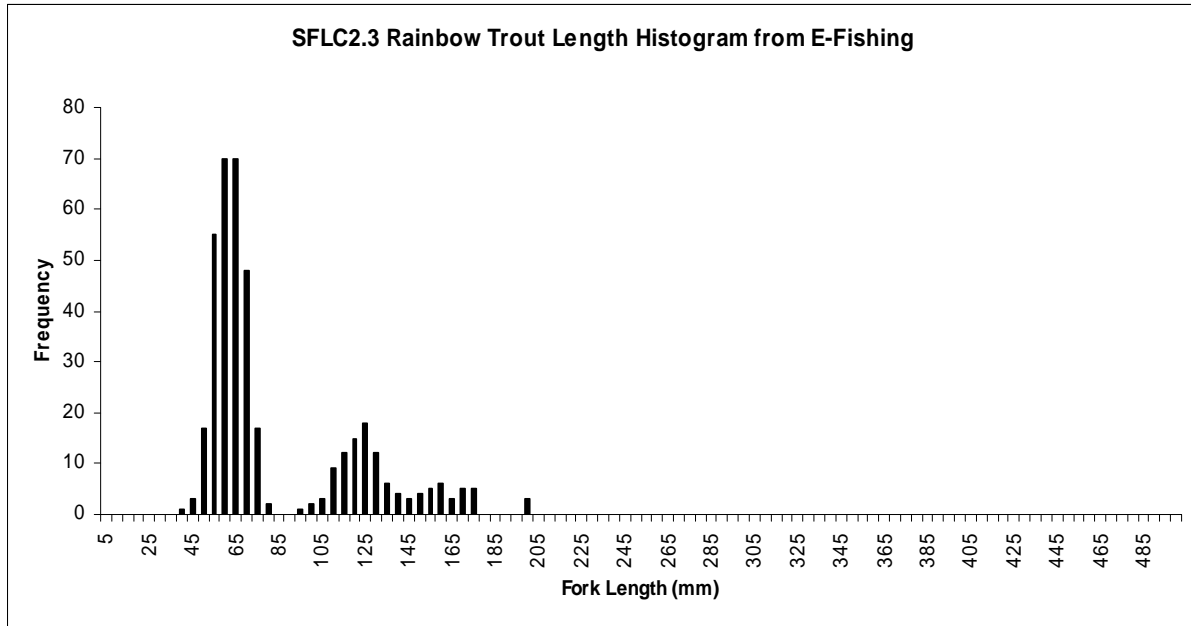
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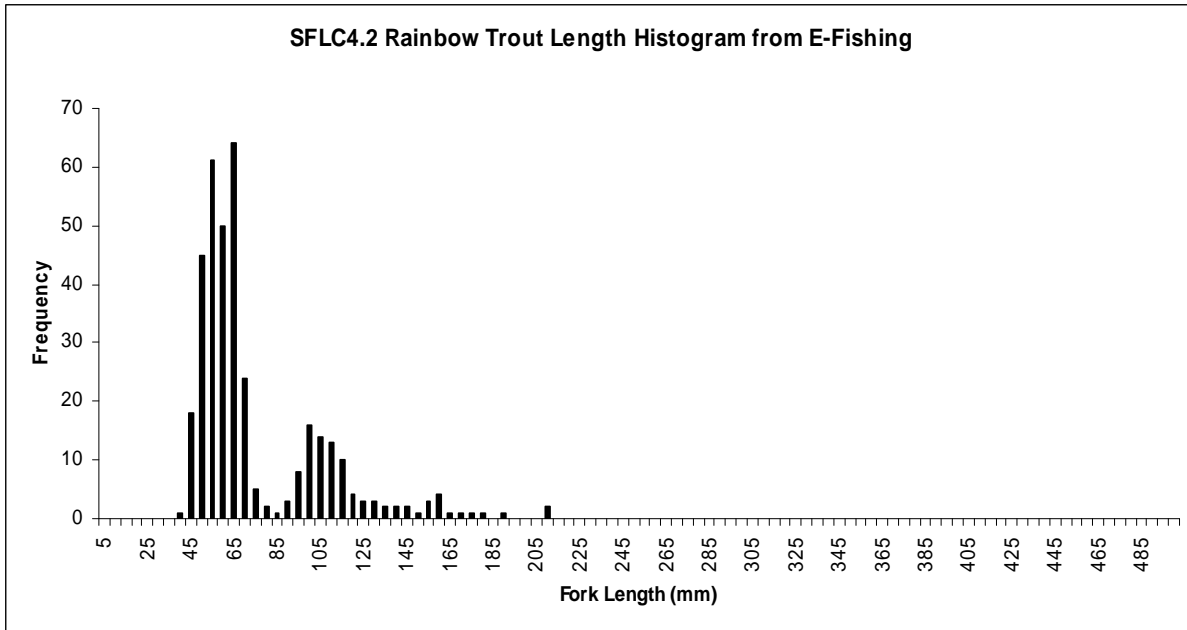
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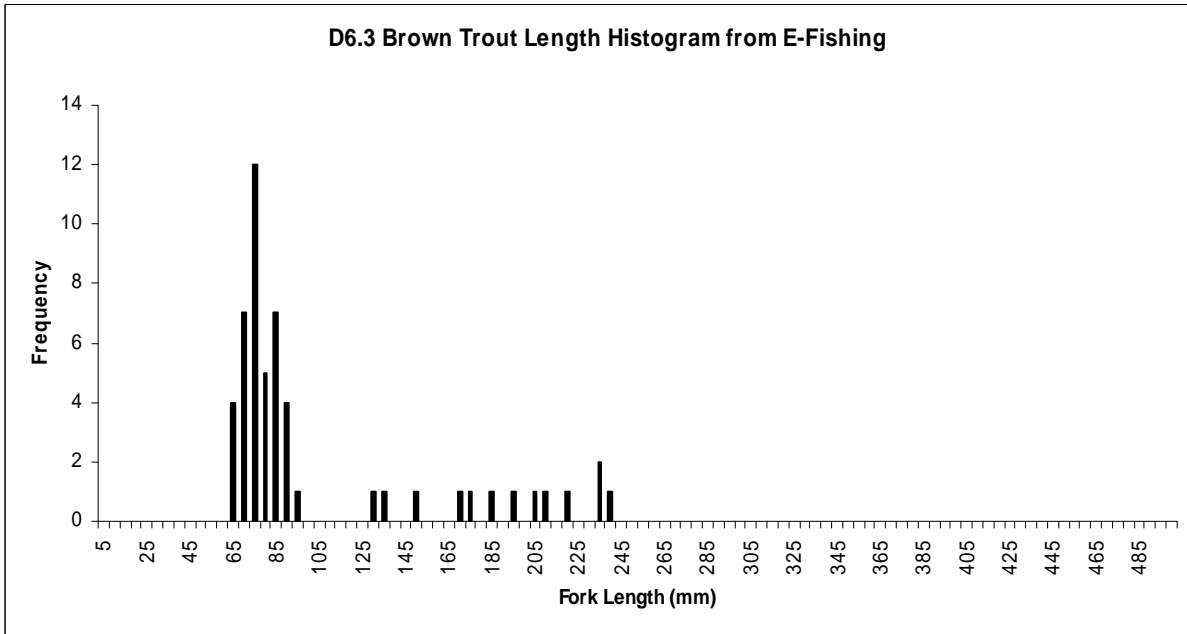
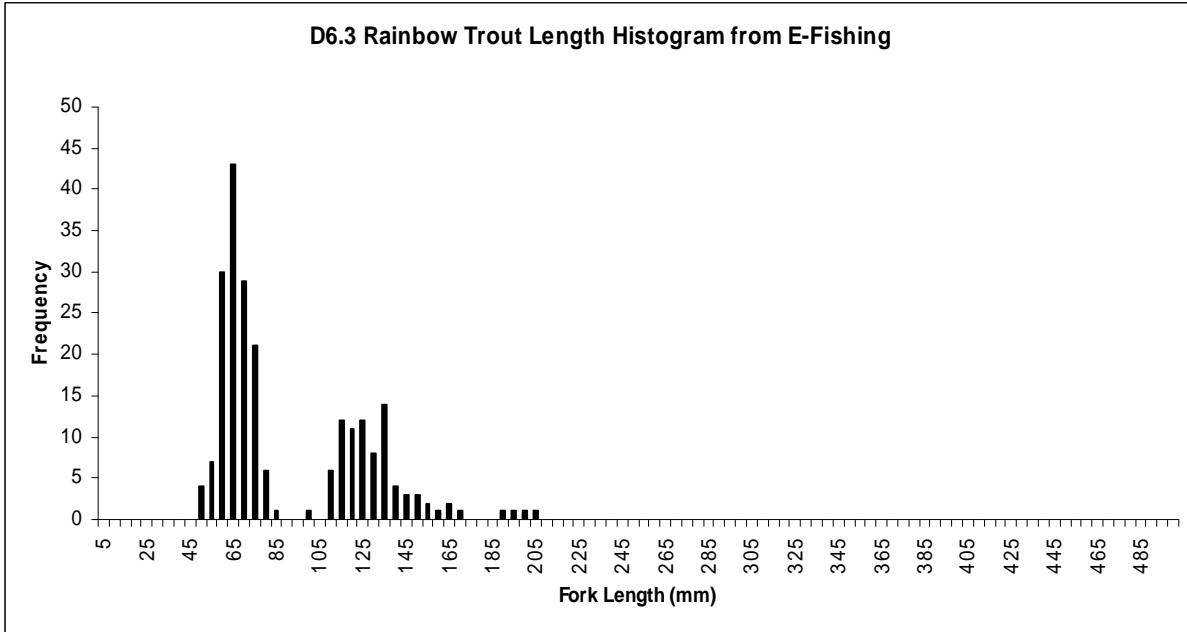
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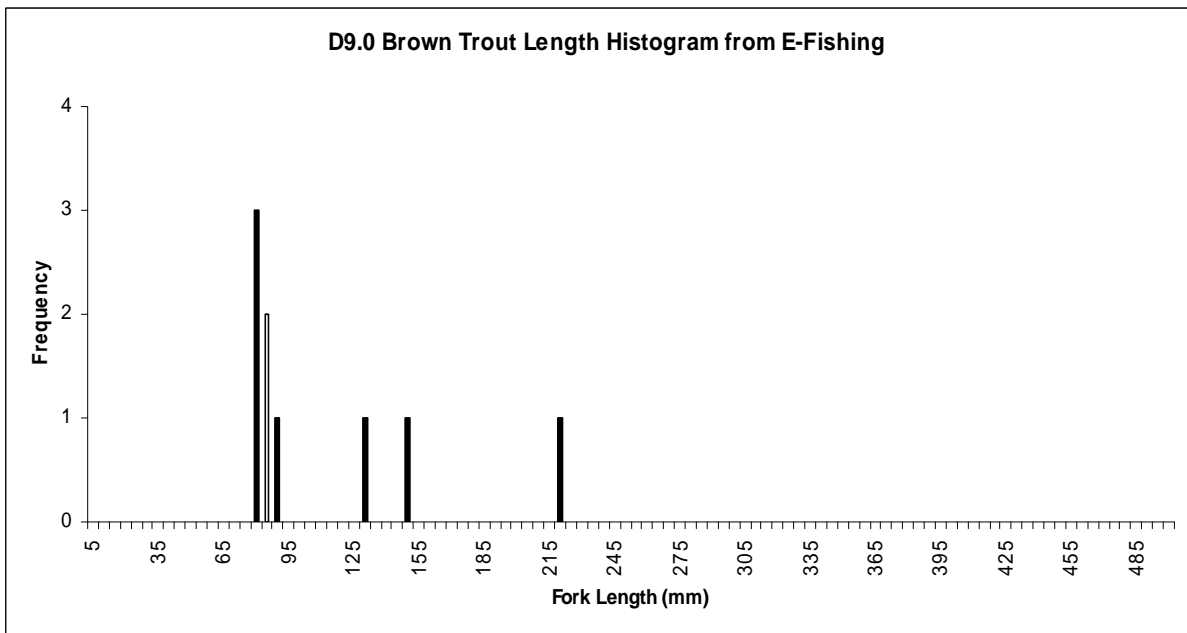
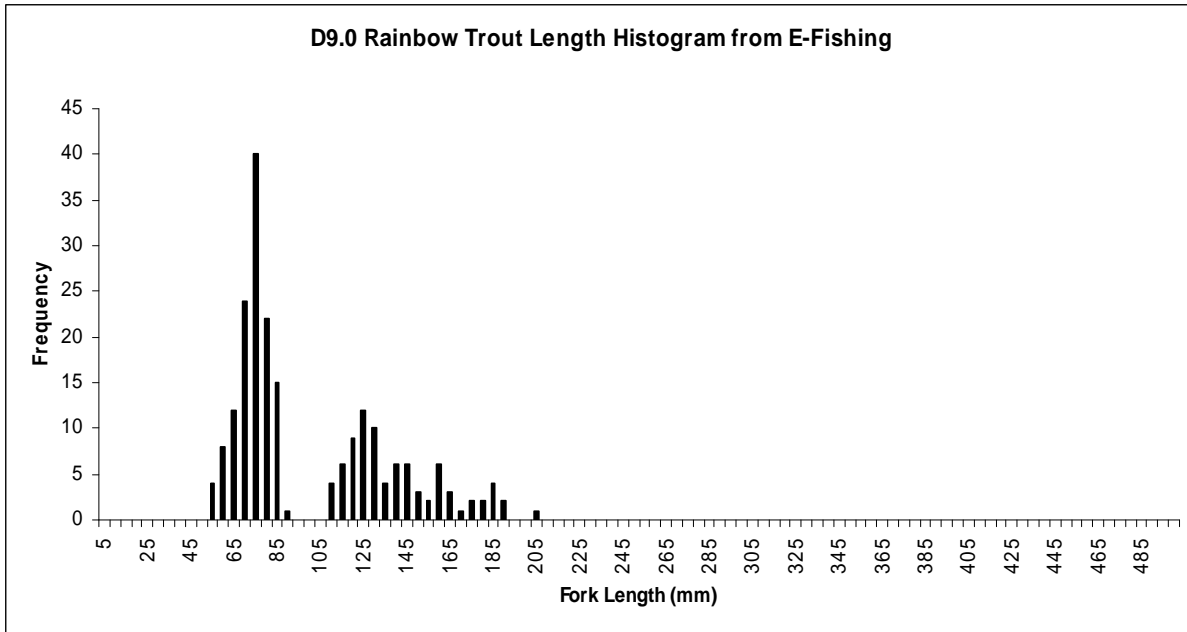
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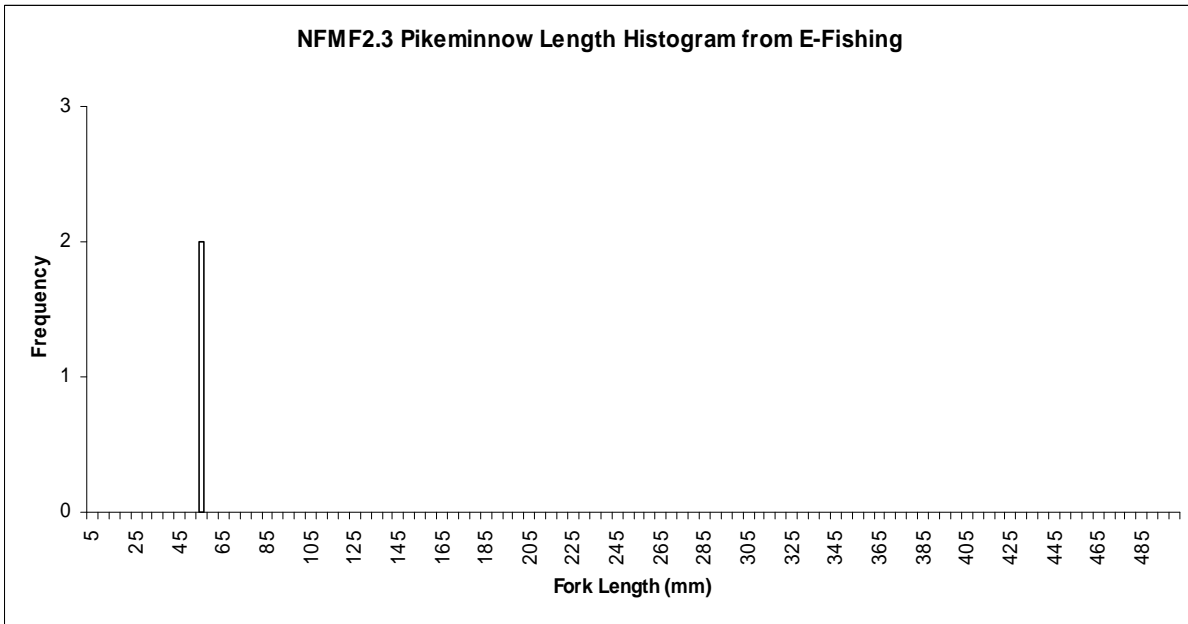
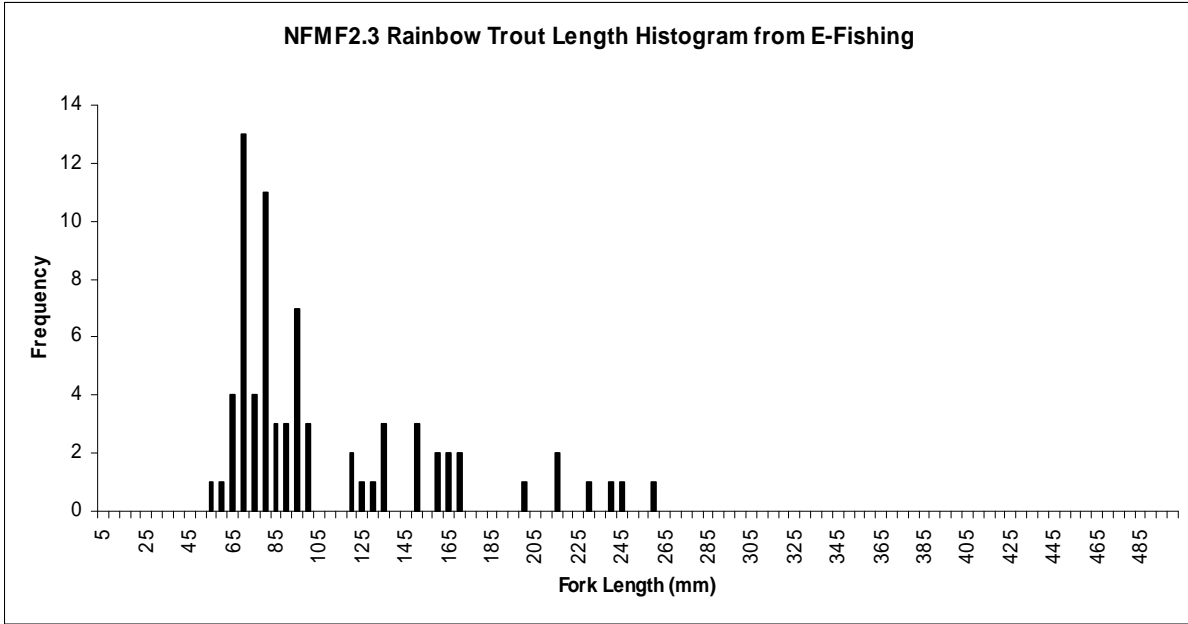
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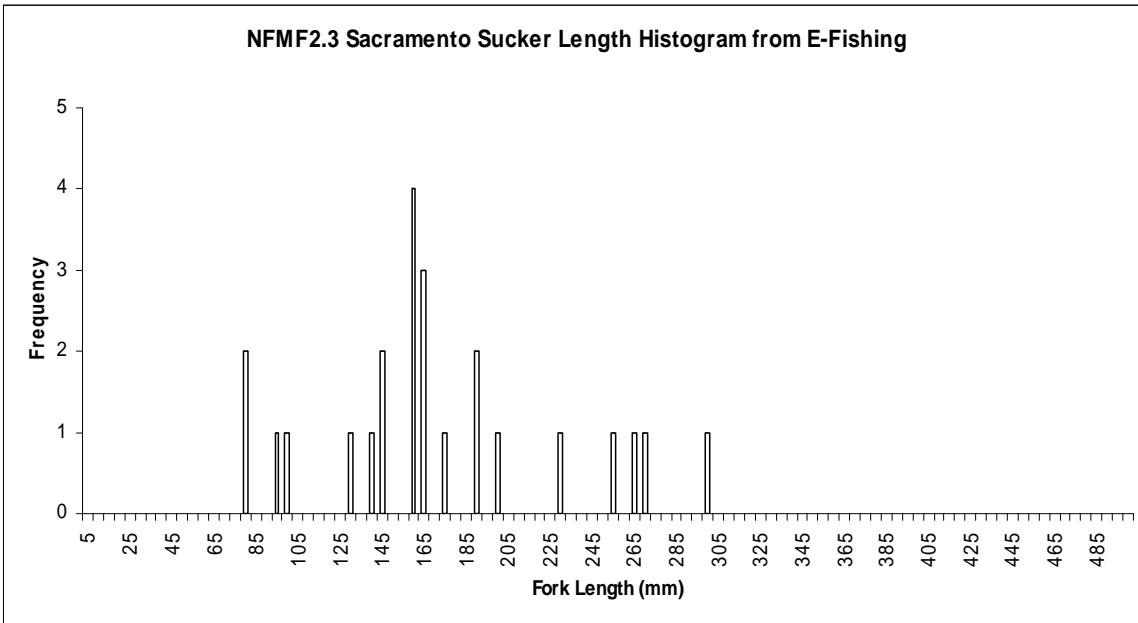
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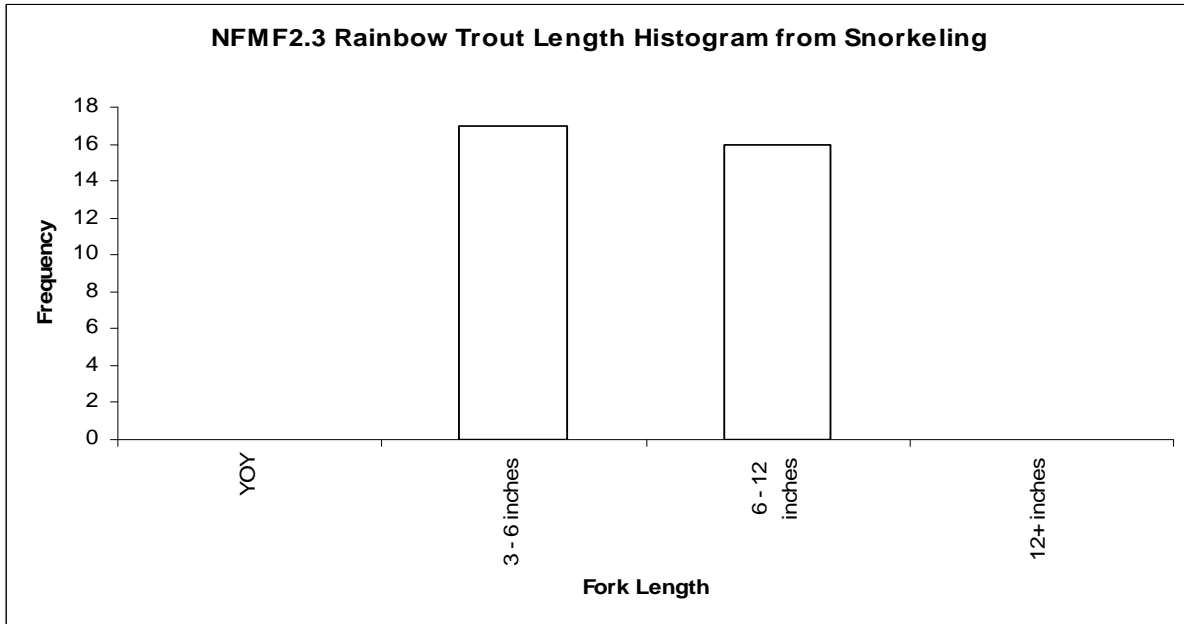
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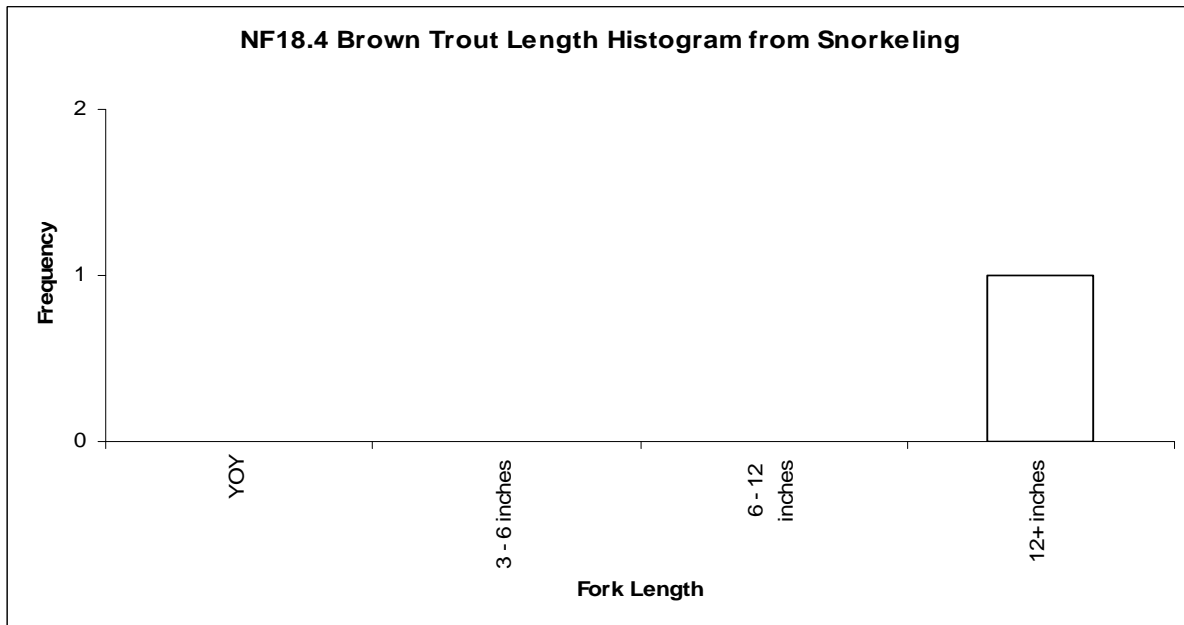
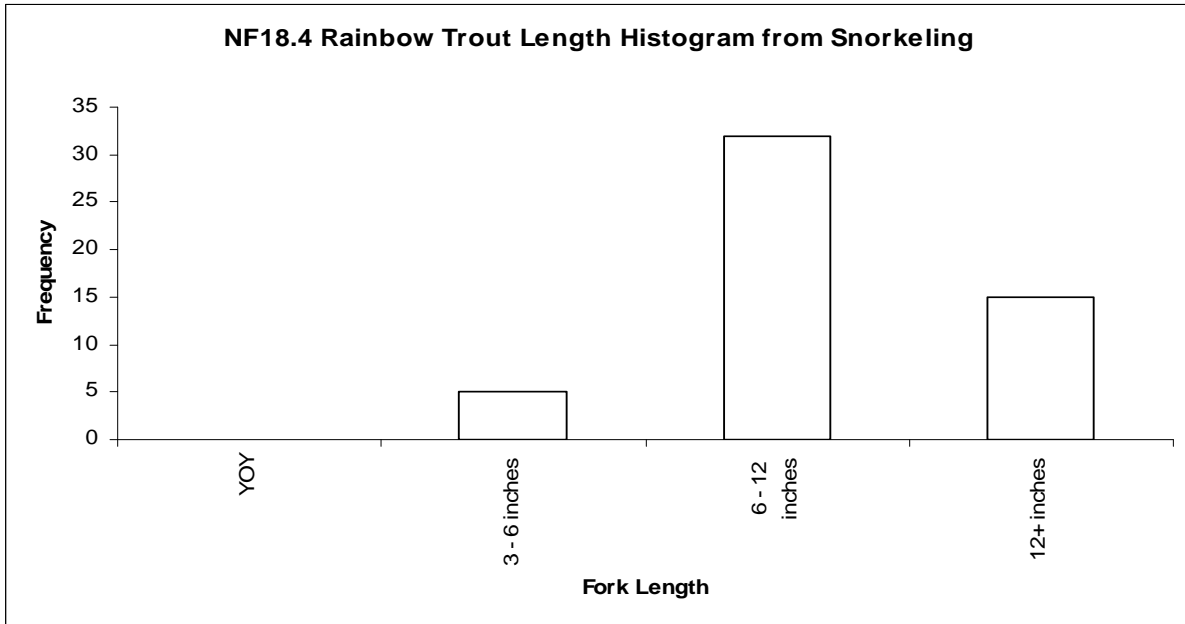
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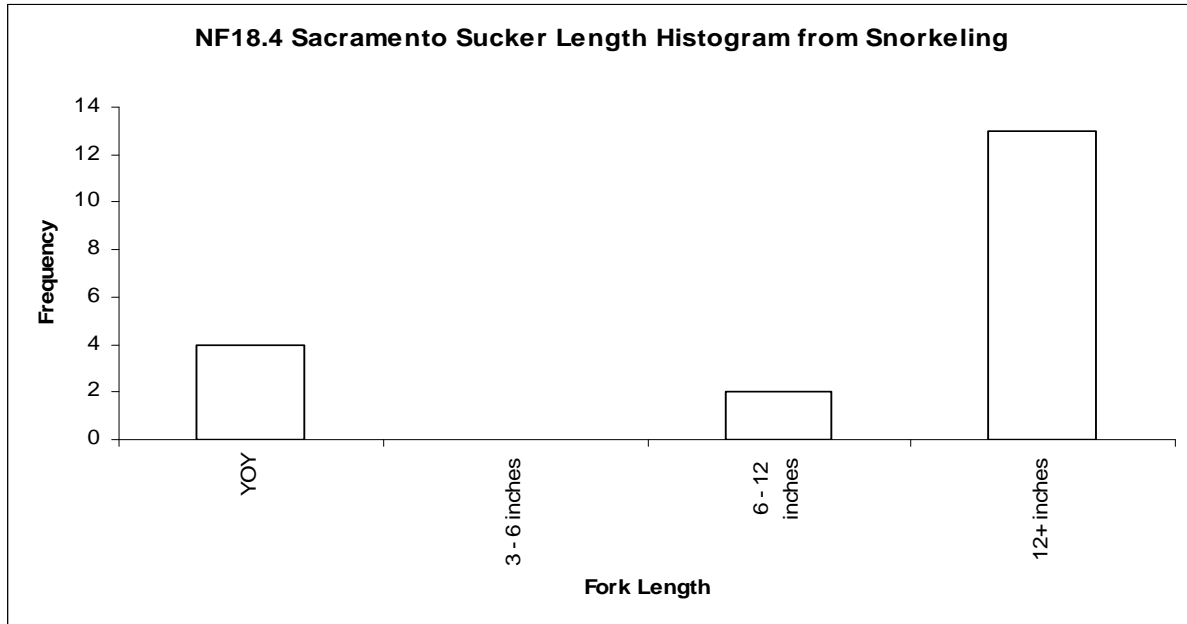
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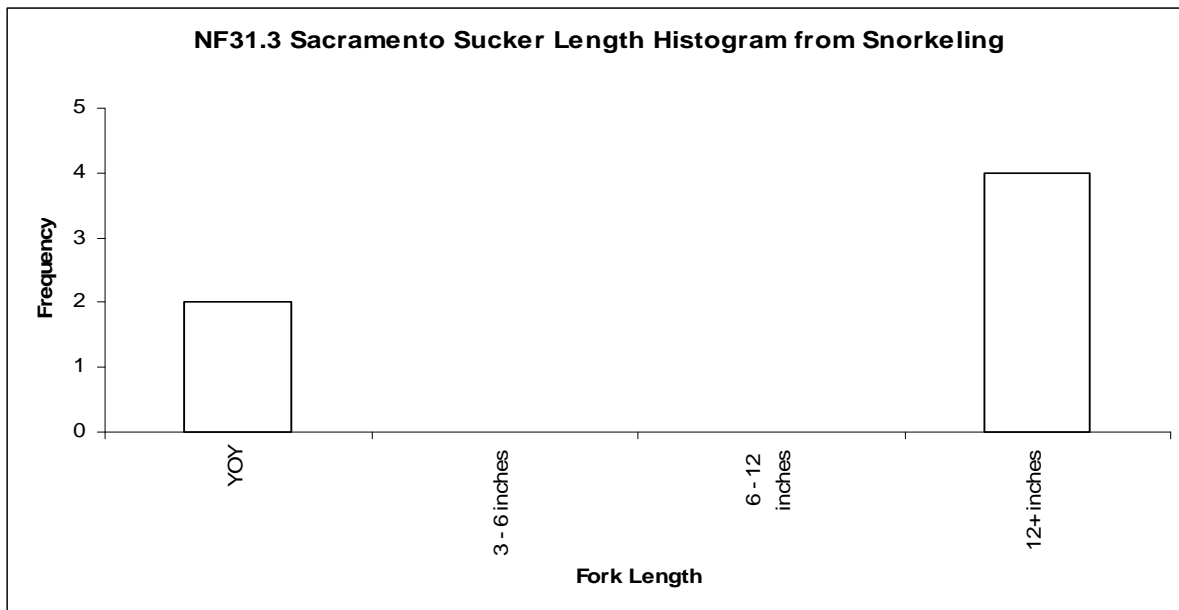
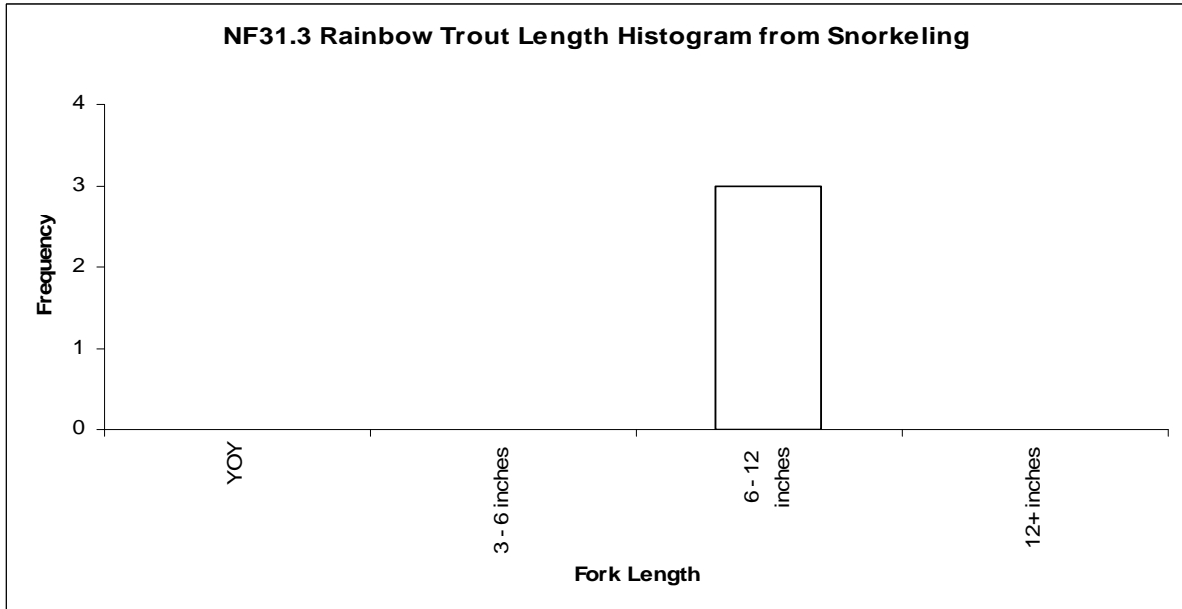
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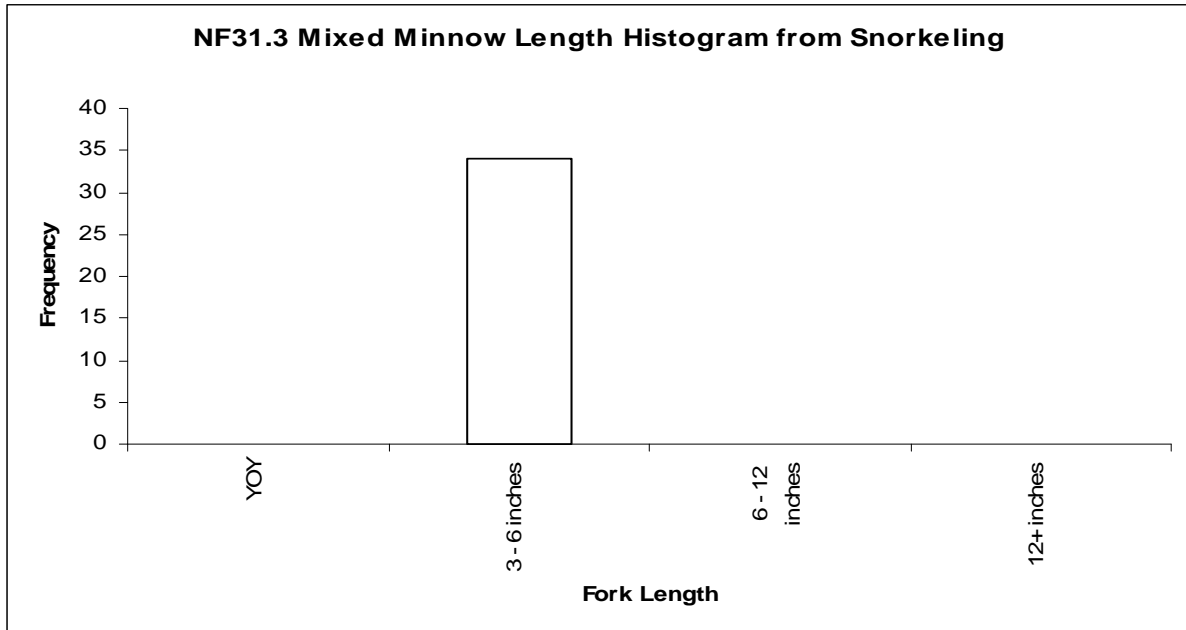
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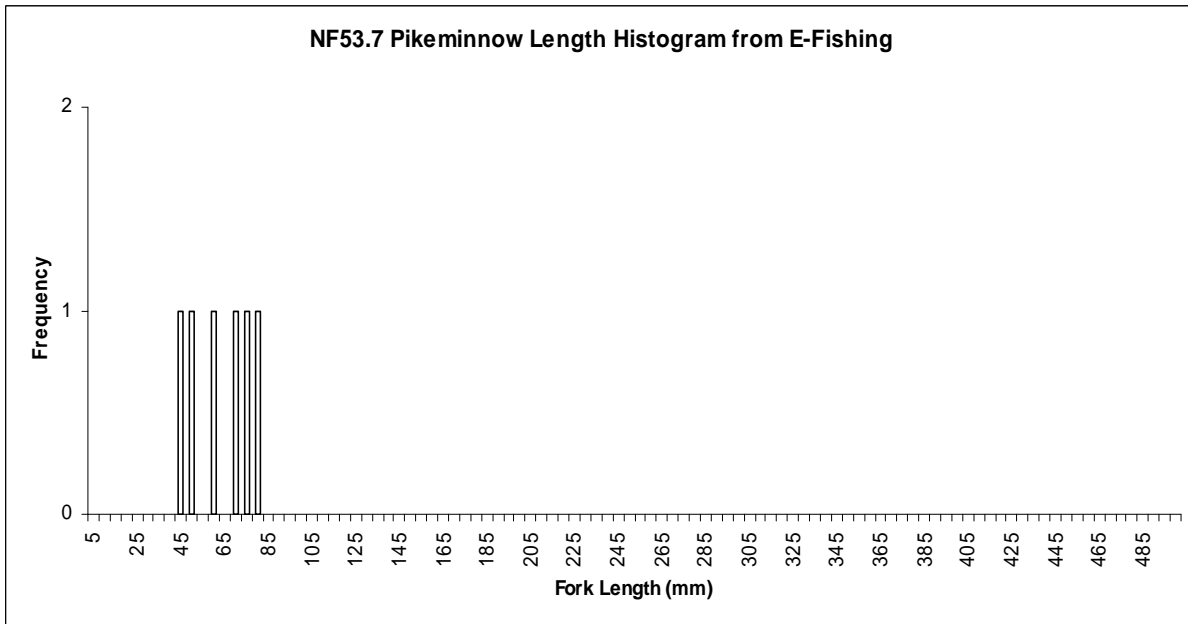
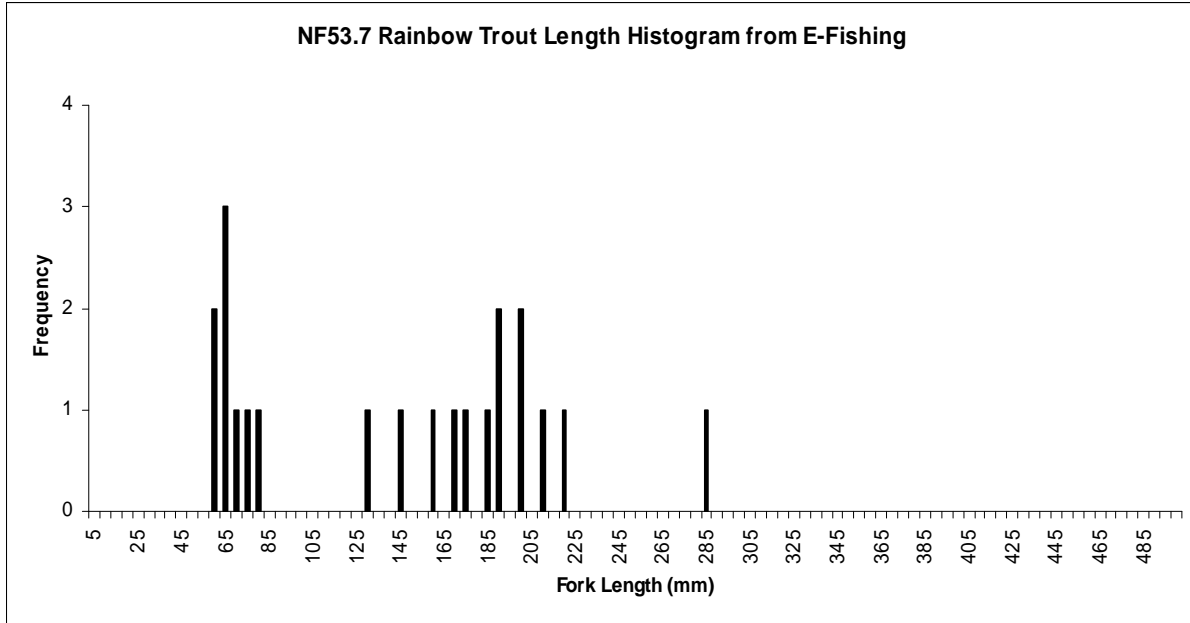
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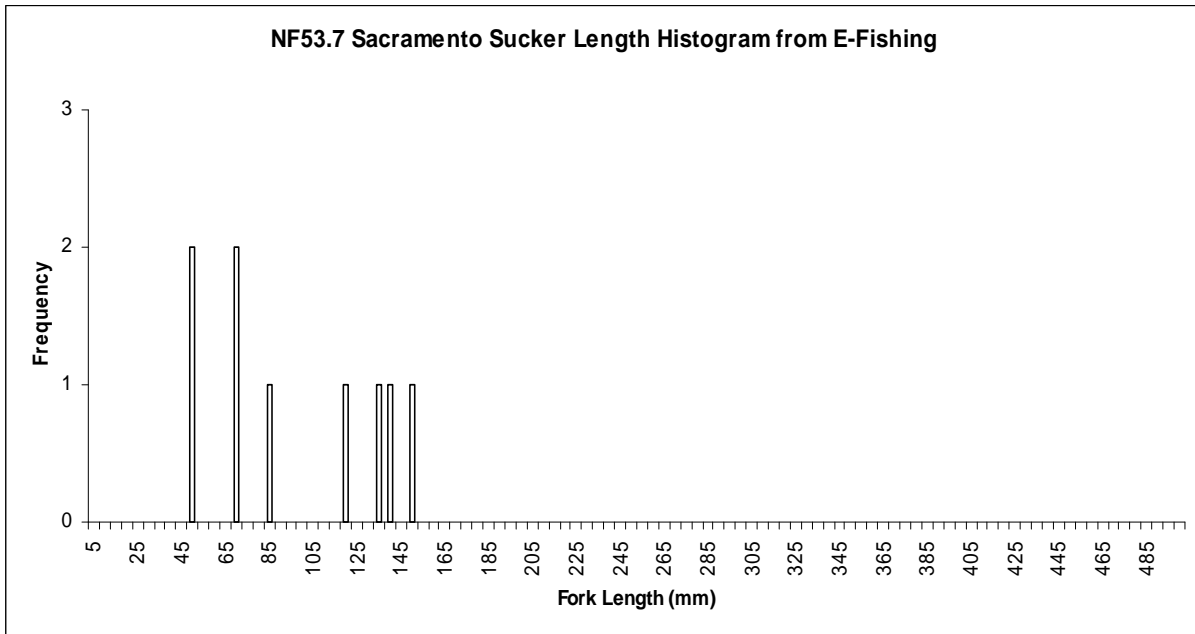
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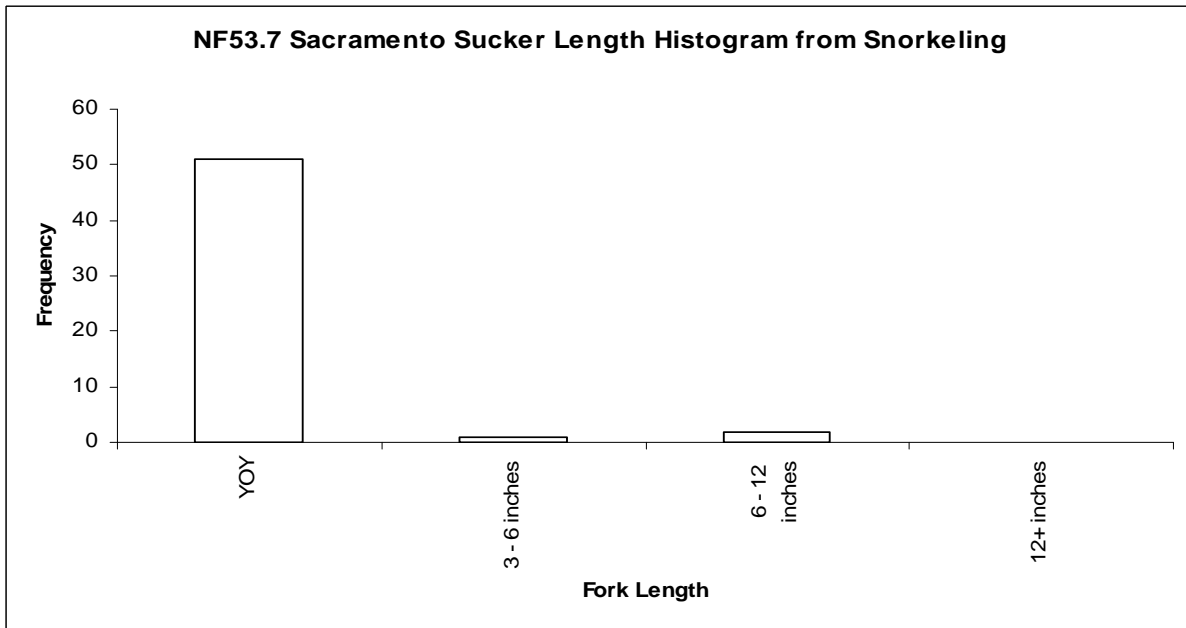
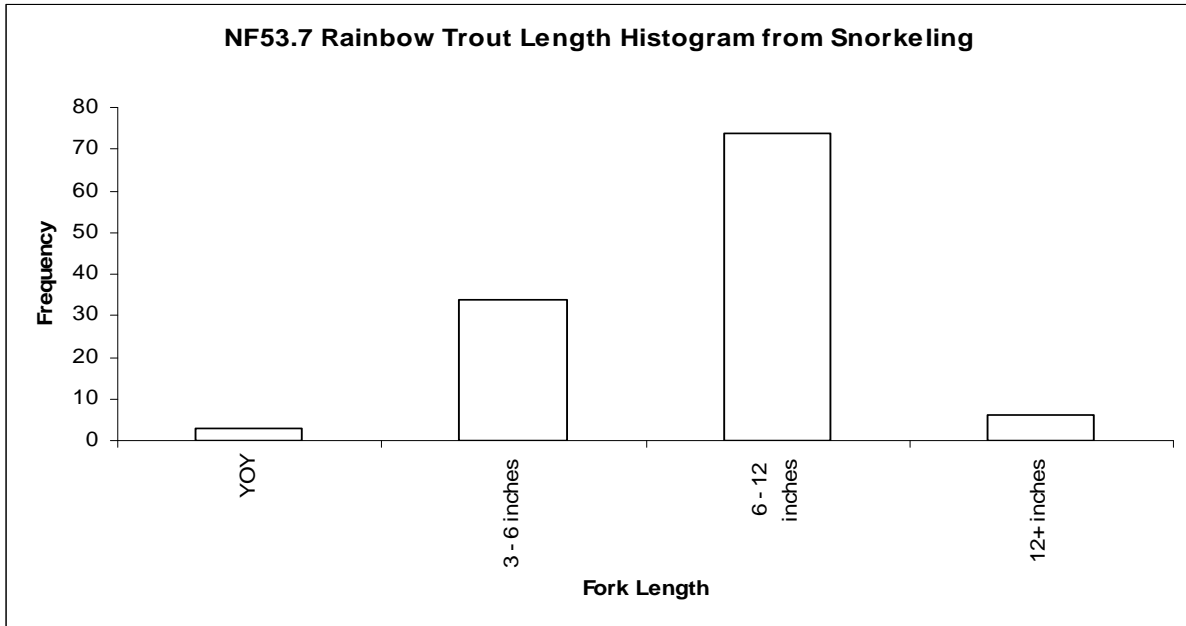
Appendix E. Length Frequency Histograms



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