LOWER YUBA RIVER ACCORD MONITORING AND EVALUATION PLAN

ANNUAL ESCAPEMENT SURVEY REPORT

SEPTEMBER 8, 2009 – JANUARY 14, 2010

Prepared for: The Lower Yuba River Accord Planning Team

by

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1. INTRODUCTION

The lower Yuba River Accord (Accord) consists of a Fisheries Agreement and several other elements. The Fisheries Agreement includes descriptions of the River Management Team (RMT), the River Management Fund (RMF), and the Monitoring and Evaluation Plan. The Fisheries Agreement in its entirety can be found on the Accord RMT website[1].

The RMT Planning Group includes representatives of the California Department of Fish and Game (CDFG), National Marine Fisheries Service, Pacific Gas and Electric, U.S. Fish and Wildlife Service, Yuba County Water Agency, and one representative for the four non-government organizations (Friends of the River, South Yuba River Citizen's League, The Bay Institute and Trout Unlimited) that are parties to the Fisheries Agreement. The RMT planning group has developed a Monitoring and Evaluation Plan (M&E Plan) to guide study efforts through the efficient expenditure of RMF funds.

The M&E Plan will provide monitoring data necessary to evaluate whether flow schedules described in the Accord are maintaining fish in good condition as defined by the Viable Salmon Population (VSP) concept developed by McElhany *et al*. (2000). The VSP conceptual architecture utilizes measures of abundance, productivity, diversity, and spatial structure to assess the long-term sustainability of salmonid populations. The M&E Plan uses the VSP framework to evaluate the efficacy of flows prescribed in the Accord to keep fish in good condition and to maintain sustainable populations of Chinook salmon and steelhead trout in the lower Yuba River. Performance indicators and associated analytics were developed for each parameter to assess Chinook salmon and steelhead trout populations on an annual and multi-year basis.

Multiple survey techniques will be utilized to address the specific analytics that are necessary to evaluate the performance indicators detailed in the M&E Plan. Adult Chinook salmon abundance will be monitored via annual escapement surveys. These surveys have served as the basal data collection procedure used to estimate the annual run size of adult Chinook salmon throughout the California Central Valley, and have become an integral component of ocean and inland fisheries management.

Since 1953, escapement surveys have been conducted on the lower Yuba River, although methods have varied considerably. Historical reports list non-uniform sampling procedures including differing survey reach demarcations, varying survey duration and sampling areas. Many models were used for population estimation (i.e. Peterson, Jolly-Seber, Schaefer) over the years. Additionally, the lower Yuba River from the Narrows Pool downstream to the State Route 20 (SR20) Bridge (also referred to as the Blue Point Mine Reach or Rose Bar Reach) was not surveyed from 1973-1993[2] (Nelson and Hill 1995). Escapement surveys were frequently attempted on this reach, but seldom were completed because of inclement weather, inaccessibility and/or turbid storm flows. As a result, most estimates from survey attempts in this section have been rejected due to low statistical confidence. In lieu of data-driven estimates, CDFG applied a 15.5% expansion to the total lower Yuba River estimate (SR20-mouth) to produce escapement estimates above SR20 from 1973-1993[3] (Nelson and Hill 1995).

Recent surveys (1994 and 1996-present) have been more consistent in both duration and area of survey, resulting in comparable escapement estimates. This year's survey on the lower Yuba River incorporates the methods of more recent escapement protocols.

The purpose of this annual escapement survey report is to; 1) document findings for the performance indicators in the M&E Program that are dependent on annual data collection from the escapement survey;, 2) document any

[1] http://www.yubaaccordrmt.com/

[2] One estimate was completed for the Rose Bar Reach during this period. The 1985 escapement survey reported an estimate for the Rose Bar Reach resulting from a five-week survey that represented 26.0% of the total escapement (Preston 1986).

[3] The 15.5% expansion factor was derived from survey observations conducted between 1966 and 1971 (Nelson and Hill 1995).

deviations from the escapement survey sampling protocols and procedures described in the M&E Program;, 3) provide recommendations for future escapement survey field protocols and procedures;, and 4) provide annual stock recruitment data.

1.1. Analytics Overview

Several analytic applications have been identified in the M&E Program framework associated with data collected from the escapement surveys. The major categories to be addressed in this annual report include escapement survey process, abundance, and diversity. A brief description of these categories is described below.

Process

- Examine the number of carcasses observed during the escapement survey.
- Examine the number of unspawned female carcasses.
- Examine coded-wire tags (CWT) and Floy tags recovered from Chinook salmon carcasses.
- Examine the relative cumulative temporal distribution of carcasses observed during the escapement survey.
- Examine the temporal and spatial distribution of observed fresh carcasses.
- Compare flow, water temperature, and turbidity to the temporal distribution of observed fresh carcasses.

Abundance

- Identify or differentiate spring- and fall-run Chinook salmon in the lower Yuba River.
- Estimate the total abundance of spring- and fall-run Chinook salmon in the lower Yuba River.
- Estimate the abundance of spring- and fall-run Chinook salmon of hatchery and natural origin in the lower Yuba River.
- Compare annual Yuba River run size for spring- and fall-run Chinook salmon with other Central Valley rivers.

Diversity

- Examine the size structure and the variation in the size structure of the total run (hatchery and natural origin) and of natural origin spring- and fall-run Chinook salmon annual runs.
- Examine the age structure and the variation in the age structure of the total (hatchery and natural origin) and of natural origin spring- and fall-run Chinook salmon.
- Estimate sex composition by age for the total (hatchery and natural origin) population and of natural origin adults, and determine the variability in sex composition of the adult population (by age) for spring- and fall-run Chinook salmon.

2. FIELD METHODS

Detailed field sampling methods are described in the Escapement Survey Protocols and Procedures (see Appendix G of the M&E Plan).

2.1. Deviations from the Escapement Survey Protocols and Procedures

A total of 41 spring-run Chinook salmon[4] were Floy-tagged (30 of which had acoustic transmitters) during May 2009 as part of a pilot acoustic telemetry study. Floy-tagged carcasses recovered during weekly escapement

[4] All tagged Chinook salmon were captured below Daguerre Point Dam between May 12, 2009 and May 26, 2009, and thus were assumed to be spring-run based upon ontogenetic characteristics and phenotypic expression of run timing consistent with spring-run Chinook salmon from other Central Valley streams. Genetic analysis of tissue samples collected from these tagged fish is in progress.

surveys were sampled for otoliths, regardless of state of decomposition, as part of a study targeting specific life history attributes (e.g. river origin, freshwater residency, time of emergence, time of smoltification, etc.) using a detailed microchemical and structural analysis of collected otolith samples. A brief summary of these observed carcasses is included in this report. A more thorough analysis and report detailing the results of these samples will be available in April 2011.

Decomposed carcasses were sampled for CWTs from September 8, 2009 to September 30, 2009. These additional collections did not affect normal sampling of fresh carcasses.

A Secchi disk was used in lieu of turbidity samples during the 2009 survey period, as turbidity measurements that record water transparency (as a function of the concentration of suspended solids) were found to inaccurately represent the ability of an observer to see through the water column. Water surface irregularities and ambient light reflectivity due to wind, rain, cloud cover and the sun's angle of incidence are not accounted for, and thus the ability of an observer to see a submerged carcass was better represented by Secchi measurements.

3. DATA ANALYSIS METHODS

3.1. Escapement Survey Process

The number of carcasses observed during the 2009 escapement survey was reported in a tabular format for each survey week including an enumeration of the following: female and male adult carcasses tagged, female and male grilse carcasses tagged, adult and grilse fresh carcasses chopped, adult and grilse non-fresh carcasses chopped, and adult and grilse carcasses recaptured.

Spawning status of fresh female carcasses was enumerated and compared to previous year's data.

Coded-wire tags recovered during the 2009 escapement survey were reported in tabular format with the following data: CWT number, recovery date, brood year, race, hatchery origin, release location, sex, and fork-length.

To describe the temporal distribution of fresh carcasses observed during the 2009 escapement survey, a cumulative distribution plot was developed. This matrix included a standard seven-day week as the independent variable and a weekly cumulative fraction of observed fresh carcasses was the dependent variant.

Frequency histograms were utilized to describe the temporal and spatial distribution of fresh carcasses observed each survey week during the 2009 escapement survey.

3.2. Abundance

A weekly mark-recapture population model (Schaefer 1951; Taylor 1974) was used to estimate adult Chinook salmon abundance using the adult carcass data. Separate estimates could not be created for each of the reaches due to low sample size. The modified-Schaefer model is represented by:

$$E = \sum E_{ij} = \sum \left(R_{ij} * \frac{M_i}{R_i} * \frac{C_j}{R_j} \right) - \sum_{i=2}^{n} M_i \quad ;$$

where E is the abundance estimate, E_{ij} is the population size during tagging period i recovery period j, R_{ij} is the number of carcasses tagged in the i^{th} tagging period that are recovered in the j^{th} recovery period, M_i is the number of fresh adult carcasses tagged in the i^{th} tagging period, C_j are the number of adult carcasses (i.e., adult chops,

adult recaptures, adults tagged) examined for tags in the j^{th} recovery period, R_i is the total number of recaptures of tagged carcasses in the j^{th} recovery period.

The abundance of grilse could not be estimated using the modified-Schaefer model due to the relatively low occurrence of grilse carcass observations during weekly surveys. In lieu of the modified-Schaefer model, an estimate of Chinook salmon grilse was derived from the adult Schaefer abundance estimate. The grilse abundance was estimated by applying an observed adult to grilse ratio (from fresh carcasses only) to the adult abundance estimate. The resultant grilse abundance estimate was then summed to the adult abundance estimate to arrive at a total abundance estimate for all Chinook salmon in the lower Yuba River.

Abundance estimates and analyses associated with hatchery origin and natural origin Chinook salmon were not possible because; 1) the analysis of otoliths that were collected during the 2009 escapement survey to identify natal origins will not be available until April 2011;, and 2) full cohort reconstruction from the CDFG's Constant Fractional Marking Program will not be possible until age-4 and age-5 returns are recovered during the fall of 2010 and 2011, respectively.

To differentiate spring- and fall-run Chinook salmon, temporal modalities associated with fresh carcass observations were examined and compared with the frequency of redds observed during the 2009 pilot redd survey. Temporal modes were also compared with the cumulative distribution of observed carcasses and redds and the occurrence frequency of Chinook salmon passing DPD as observed by infrared video monitoring systems (Vaki Riverwatcher). This examination did not provide a clear distinction between spring- and fall-run Chinook salmon. Therefore, escapement data were not reported by run and all analyses were completed using Chinook salmon data from all runs (spring-, fall- and late fall-run) collected during the entire survey. Fall-run Chinook salmon escapement survey collections include spring- and late fall-run Chinook salmon.

Annual indices of Chinook salmon abundance estimates in the lower Yuba River were compared to other Central Valley Rivers. The annual abundance for other Central Valley Rivers were obtained from GrandTab[5] for fall-run Chinook salmon in the following rivers: Sacramento River, Battle Creek, Deer Creek, Clear Creek, Cottonwood Creek, Cow Creek, Bear Creek, Mill Creek, Deer Creek, Butte Creek, Feather River, American River, Cosumnes River, Mokelumne River, Stanislaus River, Tuolomne River, and the Merced River.

3.3. Diversity

Length-frequency analyses were compiled to illustrate the size structure of the lower Yuba River Chinook salmon population. The size structure of the total population including natural origin and hatchery origin length frequencies were developed using fork length measurements from fresh carcasses observed during the 2009 escapement survey. Length frequencies were also examined to describe the annual size structure for each sex. Descriptive statistics were used to illustrate the 2009 Chinook salmon total population size structure as well as the size structure for each sex.

The age structure and size-at-age for each age group of the 2009 Chinook salmon population could not be examined at this time. Data from the CDFG Scale-Aging Program for this analysis was unavailable (Pers. Comm., B. Kormos, CDFG).

4. RESULTS

4.1. Escapement Survey Process

[5] GrandTab is a compilation of annual population estimates for Chinook salmon, Oncorhynchus *tshawytscha*, in the Sacramento and San Joaquin River systems. GrandTab is available for download at: http://www.calfish.org/IndependentDatasets/CDFGFisheriesBranch/tabid/157/Default.aspx

The 2009 escapement survey was conducted from September 8, 2009 to January 14, 2010. A summary of data collected during the escapement survey is described in Table 1.

During the 2009 escapement survey, field crews visually estimated the spawning status of all fresh female carcasses (spawned or unspawned). A total of 245 fresh female adult carcasses were visually inspected for spawning of which ten were categorized as unspawned (4.1%). Thirty percent (n=3) of the unspawned fresh females were adipose fin clipped.

The 2009 escapement survey collected a total of 454 otoliths. Three were collected from floy-tagged decomposed carcasses from the pilot acoustic telemetry project. A subsample of 100 otoliths was sent to Dr. Rachel Barnett-Johnson for initial analysis.

A total of 87 heads[6], representing 19 percent of all fresh carcass observations, were collected from adipose fin clipped carcasses on the lower Yuba River from September 8, 2009 to January 14, 2010 (Table 3). The observed ratio of clipped to non-clipped fish was 1:4.4. Coded-wire tags were undetectable for eight of the 87 (9.2%) fresh heads collected. Thirty-six (41%) of the clipped fish were female and 51 were male. Feather River Hatchery accounted for 85 percent of recoveries (n=74). Coleman National Fish Hatchery accounted for 3.4 percent (n=3) and the Mokelumne (n=1) and Nimbus Hatcheries (n=1) each represented 1.1 percent of CWT recoveries (Table 4). Forty-eight percent (n=42) of the CWT collections in 2009 were designated to be spring-run, 41.2 percent (n=36) were designated fall-run, and 1.1 percent (n=1) was determined to be late fall-run Chinook salmon (Table 5). All spring-run Chinook salmon CWT carcasses were of Feather River Hatchery origin, while the single late fall-run Chinook salmon recovery was from Coleman National Fish Hatchery.

Three brood years were represented by CWT recoveries during the 2009 escapement period (2005, 2006 and 2007). Brood stock from 2005 represented 10.3 percent (n=9), whereas the 2006 and 2007 brood years were equally represented 40.2 percent (n=35) of CWT recoveries (Table 5).

CWT Chinook salmon release locations were summarized in Table 6. Additionally, no natural origin CWT recoveries from CDFG's Lower Yuba River Life History Investigations were observed during the 2009 escapement survey. Natural origin juvenile Chinook salmon were captured via rotary-screw traps in the lower Yuba River; captured juvenile Chinook salmon representing brood years 2003-2006 were manually tagged with half-length alphanumeric CWTs and released into the lower Yuba River. To date, eight California ocean recoveries and six freshwater escapement recoveries have been observed from the 680,811 total fish tagged from the project.

The recapture rate for marked Chinook salmon carcasses during the 2009 survey period was 40 percent (136 recoveries/336 tagged). This was compared to the 2008 survey which had very similar results with a recapture rate of 39 percent (127 recoveries/327 tagged). Additionally, four carcasses from the 2009 spring-run Chinook salmon acoustic tagging pilot study were recovered during the 2009 escapement survey period. These recoveries represent a 9.7 percent recovery rate for all Floy-tagged fish (n=41). All Floy recoveries were observed above the SR20 Bridge.

A cumulative distribution of fresh Chinook salmon carcasses observed during the sample period was developed to examine the temporal distribution of fresh carcasses observed during the season (Figure 1). By October 13, 2009, 54 percent of all fresh carcasses were observed, and 80 percent of all fresh carcasses were observed by October 27, 2009.

[6] A deviation in protocol resulted in an additional 15 heads collected from decomposed carcasses from September 8, 2009 to September 30, 2009. The results from these collections were not included in this analysis, but a summary has been provided for supplemental purposes (Table 2).

Most fresh Chinook salmon carcasses were observed above DPD (Figure 2). Eighty-five percent of fresh carcasses were observed above DPD and 15 percent were observed below. Of the total number of fresh carcasses observed, 49.4 percent were between the Narrows Pool and the SR20 Bridge, 35.4 percent were between SR20 Bridge and DPD, and 15.2 percent were between DPD and Simpson Lane Bridge.

Fresh carcasses were observed from September 8, 2009 through January 5, 2010 from the Narrows Pool to SR20 Bridge. From the SR20 Bridge to DPD, observations occurred from September 8, 2009 through November 23, 2009. Peak observations for both reaches occurred on October 6, 2009 and October 13, 2009, respectively (Figure 3). Additionally, fresh Chinook salmon carcasses were observed between DPD and Simpson Lane Bridge from September 15, 2009 through the end of the survey period on January 14, 2010. Modal peaks were noted on October 21, November 10 and November 23, 2009.

Mean daily flow at the U.S. Geological Survey (USGS) Smartsville gage during the survey period ranged from 702 cfs to 894 cfs with a mean of 807 cfs (Figure 4). Mean daily flows at the USGS Marysville gage ranged from 525 cfs to 800 cfs with a mean of 601 cfs (Figure 5).

Water visibility was generally conducive to field observations during the survey period. Observed Secchi disk measurements ranged from 1.0 to 4.5 meters with an average of 3.1 meters (Figure 6). Visibility decreased during and shortly following storm events late in the survey because of turbid inflows from Deer and Dry Creeks.

Mean daily water temperatures were observed from the USGS Smartsville gage. The temperature at this site ranged from 8.1 °C to 12.1 °C, with a mean daily water temperature for the entire survey period of 10.3 °C (Figure 7). The daily average water temperature was 11.3 °C when spawning was first observed.

4.2. Abundance

In an attempt to differentiate spring- and fall-run Chinook salmon carcasses, the temporal distributions of observed Chinook salmon carcasses (Figure 2) were examined in conjunction with data observations collected during the 2009 redd survey (Figure 8), and with observations collected from the Vaki Riverwatcher systems at DPD (Figure 9). Cumulative temporal distributions were also examined utilizing data from all three surveys (escapement, redd and Vaki Riverwatcher observations) (Figure 10). No clear spatial distinction could be made between spring- and fall-run Chinook salmon carcasses. However, data from CWT recoveries and the pilot redd survey suggest that some temporal separation exists between runs[7].

The adult Chinook salmon abundance estimate from the modified-Schaefer model was 3,992. The grilse abundance estimate was calculated using an observed adult to grilse ratio of 4.97:1 (n = 388:78), resulting in a grilse abundance estimate of 803. The total abundance of Chinook salmon (adult and grilse) returning to the lower Yuba River was estimated to be 4,795 (Table 7). A total of 336 fresh carcasses were tagged and released, and a total of 136 of these tagged fish were recaptured. This represents a recapture rate of 40 percent for all carcasses tagged. Harvest by recreational fisheries in the lower Yuba River was not incorporated into the abundance estimate because no legal harvest occurred due to statewide ocean and inland fisheries closures in 2009.

4.3. Diversity

The size of all fresh Chinook salmon sampled (n = 466) ranged from 455 mm to 1,130 mm and the average size was 788 ± 11.46 mm (95% CI). The most frequently observed length for Chinook salmon was 740 mm and the

[7] See discussion on page 11.

median length was 795 mm (Table 8). Of the 466 fresh carcasses examined, 245 fish (52.6%) were females and 221 fish (47.4%) were males, resulting in a female to male ratio of 1.1:1.

All fresh female Chinook salmon carcasses sampled (n = 245) ranged from 540 mm to 960 mm with an average size of 782 ± 10.19 mm (95% CI). The most frequently observed length for female Chinook salmon was 790 mm and the median length was 795 mm (Table 8).

Female Chinook salmon carcasses sampled that were adipose fin clipped (n = 36) ranged in size from 540 mm to 920 mm with an average size of 734 ± 32.65 mm (95% CI). The most frequently observed length for adipose fin clipped female Chinook salmon was 745 mm and the median length was 742 mm (Table 8).

Female Chinook salmon carcasses sampled that were not adipose fin clipped (n = 209) ranged in size from 560 mm to 960 mm with an average size of 790 ± 10.26 mm (95% CI). The most frequently observed length for non-adipose fin clipped female Chinook salmon was 790 mm and the median length was 790 mm (Table 8).

All fresh male Chinook salmon carcasses sampled (n = 221) ranged in size from 455 mm to 1,130 mm with an average size of 840 ± 21.42mm (95% CI). The most frequently observed length for male Chinook salmon was 910 mm and the median length was 840 mm (Table 8).

Male Chinook salmon that were adipose fin clipped (n = 51) ranged in size from 455mm to 1,000 mm with an average size of 681 ± 21.42 mm (95% CI). No mode was associated with male adipose clipped Chinook salmon length observations. The median length of male adipose clipped Chinook salmon was 610 mm (Table 8).

Male Chinook salmon that were non-adipose fin clipped (n = 170) ranged in size from 505 mm to 1,130 mm with an average size of 829 ± 22.41 mm (95% CI). The most frequently observed length for non-adipose fin clipped male Chinook salmon was 890 mm and the median length observed was 861 mm (Table 8). Length frequency distributions for all fresh Chinook salmon carcasses observed were illustrated in Figure 11.

5. DISCUSSION

Modalities associated with the spatial and temporal distribution of observed fresh carcasses from the 2009 carcass survey did not indicate a clear separation between the spring- and fall-run Chinook salmon. The overall escapement survey observations likely reflect spatially and temporally overlapping components of spring-, fall- and late fall-run Chinook salmon. Moyle (2002) found that the spawning period for spring- and fall-run Chinook salmon in the California Central Valley overlapped considerably. However, spring-run Chinook salmon CWT recoveries were consistent with known temporal distributions. Forty-two spring-run Chinook salmon CWTs were recovered from September 22, 2009 through October 21, 2009 (Figure 12); five of which were previously captured at DPD from May 12, 2009 through May 26, 2009 and released with external Floy tags for later identification during escapement surveys. Additionally, Chinook salmon redd counts from weekly redd surveys above DPD increased from September 15, 2009 through October 6, 2009; peaked on October 7, 2009, and then decreased markedly from October 8, 2009 to October 19, 2009 (Figure 8). Fresh carcass observations upstream of DPD were also on the decline following a modal peak observed on October 6, 2009 (Figure 2). These data suggest that some temporal and spatial separation between spring- and fall-runs may still exist. Unfortunately, these observations cannot be used to positively quantify the relative run size for spring- and fall-run Chinook salmon spawning populations. To address this limitation of the annual escapement data, genetic tissue samples were gathered during the 2009 escapement survey and will be analyzed with the intent of accurately designating specific run assignments to estimated adult abundance indices. Tissue samples will continue to be collected during future escapement surveys and results from this, and future studies will be reported when available.

Abundance estimates for hatchery and natural origin Chinook salmon could not be calculated because; 1) full cohort reconstruction from age-4 and age-5 returns from CDFG's constant-fractional marking program will not be

observed until the fall 2010 and 2011;, and 2) otolith microchemical and microstructural analysis results from samples collected during the 2009 escapement survey will not be available until April 2011 to definitively determine natal origins (i.e., out-of-basin hatchery, or natural origin). Otoliths will be processed by Dr. Rachel Barnett-Johnson as part of a cooperative joint project with the Accord RMT. Estimates of hatchery and natural origin contributions to lower Yuba River escapement will be later applied using data from otolith results.

Abundance estimates increased 34.7 percent from 2007 to 2008, and the 2009 estimate exhibited a 36.7 percent increase over the previous year's escapement. The Yuba River was one of six Central Valley systems to observe an increase in escapement over recent estimates (Table 9). Although these increases in escapement are promising for recovery efforts, they represent the lowest recorded returning adult escapements in recent years. The average abundance of Chinook salmon obtained from comparable methods from 1994-2005[8] was 22,155 ± 4,357 (95% CI). The minimum and maximum yearly estimates from this data series was 10,890 and 31,090 Chinook salmon, respectively.

The adult to grilse ratio (4.97:1) from fresh carcass observations during the survey period represented an increase over the grilse frequency observed in 2008. The relative proportion of grilse to adult escapement observations has increased stepwise from 2006 through 2009. The 2008 escapement survey described a larger grilse component (7.28:1) than what was observed in the previous 2007 (29.9:1) or 2006 (34.3:1) escapement surveys (Massa 2007, 2008). The Pacific Fishery Management Council uses grilse return data to estimate escapement for the following year. Larger grilse returns suggest a larger return of age three fish for the following year (Pers. Comm. J. Duran, CDFG).

The majority of fresh Chinook salmon carcasses were observed above DPD in 2009 (85%). During the 2008 escapement survey, 93 percent of the carcasses were observed above DPD (Massa *et. al*. 2009). Past escapement surveys have also found that the majority of Chinook salmon spawning in the Lower Yuba River was observed above DPD (Massa 2006, 2007, 2008; Massa *et. al*. 2009; Jones and Stokes 2006). These observations continue to provide significant support for future restoration actions on the Yuba River for spawning and rearing areas located above SR20 and DPD; and specifically for the proposed site rehabilitation at Sinoro Bar[9]. Salmon are most heavily utilizing spawning habitat upstream of SR20, as 49.4 percent of all fresh carcasses were observed during the 2009 survey period in the 6.4 kilometer reach from the Narrows pool to SR20. Areas upstream of the Narrows Pool have been identified as having suitable holding habitat, but unsuitable spawning substrate for Chinook salmon. Additionally, the natural geomorphic processes essential to providing high quality spawning habitats have been impaired through the construction of Englebright Dam. The quantity and quality of salmonid spawning habitat from Englebright Dam to the Narrows pool has been significantly reduced by the deposition of large, consolidated rock fragments (i.e. "shotrock") and lack of recruitment of new gravel from upstream. Multiple observations on habitat use from redd surveys and annual escapement surveys not only suggest that the majority of Chinook salmon utilize these areas upstream of DPD, but the observations also strongly support future restoration actions focused in these areas.

Egg retention during the 2009 escapement survey exhibited an increase over 2008 observations. All female carcasses examined in 2008 were spawned, whereas 10 of 245 fresh female carcasses inspected in 2009 were unspawned. Although these observations represent an increase above previous survey years, characterizations from lower Yuba River egg retention studies are difficult to compare, since methods have not been consistent. An egg retention study conducted in 2005 inspected every 10th fresh female carcass encountered during weekly escapement surveys though an internal inspection of the abdominal cavity. The study identified that 15 percent of the fresh female carcasses observed were either partially spawned or completely unspawned (approximately 4

[8] The 1995 escapement estimate is excluded from this analysis because methods were not consistent with the data series.
[9] Sinoro Bar is located adjacent to, and across from the Deer Creek confluence with the lower Yuba River. Sinoro Bar has been identified as an important area for SHIRA-based stream rehabilitation and has been selected as a potential site for funding through the Habitat Expansion Agreement (HEA) between California Department of Water Resources and Pacific Gas & Electric. For more information on the HEA, visit: http://www.sac-basin-hea.com. For more information on SHIRA-based stream rehabilitation, visit: http://shira.lawr.ucdavis.edu.

percent and 11 percent, respectively), and that the remaining 85 percent were completely spawned. In 2006, a similar study with revised protocols was employed. The methods were modified from the previous year's effort in 2005. The 2005 methods utilized a visual estimation of egg retention for every tenth fresh female observed. The revised methods required field extraction of the ovaries for egg counts to be completed. Following the significant number of CWT recoveries from 2005 (196 CWT heads collected that year); it was assumed that sampling only CWT recoveries for egg retention under the new protocols would provide an adequately robust dataset for analysis. However, only 27 adipose fin clipped Chinook salmon carcasses were recovered in 2006. Of the total 27 CWT adipose fin clipped carcasses recovered, only half were fresh enough for inclusion under the new methods. Furthermore, only three of the carcasses observed met the set criteria for egg collection (Massa 2007). The 2006 egg retention pilot study produced too few observations for rigorous statistical analysis and evaluation. Additionally, the 2006 escapement report noted that sampling only adipose clipped females likely misrepresented the actual level of egg retention that year due to the anecdotal observation that unspawned carcasses were frequently observed to be non-adipose fin clipped (Massa 2007), and were thus unaccounted for under the revised survey guidelines.

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Table 1. Summary observations for marked, chopped and recaptured carcasses by survey reach on the lower Yuba River, CA, from September 8, 2009 to January 14, 2010.

Survey Period	Date	Survey Reach	Adults Tagged		Grilse Tagged		Chops				Recaptures	
			Females	Males	Females	Males	Adults	Adult CWT	Grilse	Grilse CWT	Adults	Grilse
Week 1	9 /8 /2009	"Narrows – Hwy 20"	1								0	
	9 /8 /2009	"Hwy 20 – DPD"	1								0	
	9 /9 /2009	"DPD – Simpson Ln."									0	
Week 2	9 /15/2009	"Narrows – Hwy 20"									0	
	9 /15/2009	"Hwy 20 – DPD"	2				1				0	
	9 /16/2009	"DPD – Simpson Ln."						1			0	
Week 3	9 /22/2009	"Hwy 20 – DPD"	1	2							1	
	9 /22/2009	"Narrows – Hwy 20"	1	5			2	2		1	0	
	9 /23/2009	"DPD – Simpson Ln."					1				0	
Week 4	9 /29/2009	"Narrows – Hwy 20"	14	11			20	4		5	3	
	9 /30/2009	"Hwy 20 – DPD"	3	11			21	6		3	0	
	10/1 /2009	"DPD – Simpson Ln."					3	1		1	0	
Week 5	10/6 /2009	"Narrows – Hwy 20"	26	14		2	78	8	4	5	10	
	10/7 /2009	"Hwy 20 – DPD"	11	13		2	49	9	4	2	5	
	10/8 /2009	"DPD – Simpson Ln."	1	3			4	1			0	
Week 6	10/13/2009	"Narrows – Hwy 20"	25	13		9	89	3	2	4	10	
	10/14/2009	"Hwy 20 – DPD"	7	17		3	78	5	13		7	
	10/15/2009	"DPD – Simpson Ln."	2				10		3	2	0	
Week 7	10/21/2009	"Narrows – Hwy 20"	8	8	1	2	159	3	15	2	7	
	10/22/2009	"Hwy 20 – DPD"	15	4		4	140	2	31	2	18	
	10/23/2009	"DPD – Simpson Ln."	4	4		2	29	3	9	3	1	
Week 8	10/27/2009	"Narrows – Hwy 20"	16	2		1	68	1	10		9	
	10/28/2009	"Hwy 20 – DPD"	4	7	1	1	102	1	21	1	1	
	10/29/2009	"DPD – Simpson Ln."	4			1	13		1		3	
Week 9	11/3 /2009	"Narrows – Hwy 20"	5	2		2	55		8		20	1
	11/4 /2009	"Hwy 20 – DPD"	7	3	1	1	62	2	10		3	1
	11/5 /2009	"DPD – Simpson Ln."	5			1	23		6		2	1
Week 10	11/10/2009	"Narrows – Hwy 20"	3	3	1		29		2	2	3	2
	11/12/2009	"Hwy 20 – DPD"	3	3			27	1	3		6	
	11/13/2009	"DPD – Simpson Ln."	6	1	1	1	11		3		1	
Week 11	11/17/2009	"Narrows – Hwy 20"					24		2		1	
	11/18/2009	"Hwy 20 – DPD"	3	1	2		27				6	
	11/19/2009	"DPD – Simpson Ln."	2	2			8		3		2	
Week 12	11/23/2009	"Narrows – Hwy 20"	3	1			5				1	
	11/24/2009	"Hwy 20 – DPD"	2				11		1		2	
	11/25/2009	"DPD – Simpson Ln."	8	1	1		10		3		2	
Week 13	12/1 /2009	"Narrows – Hwy 20"					7				1	
	12/2 /2009	"Hwy 20 – DPD"					6		1		1	
	12/3 /2009	"DPD – Simpson Ln."	4	1			11			1	2	
Week 14	12/8 /2009	"Narrows – Hwy 20"					1		1		1	
	12/9 /2009	"Hwy 20 – DPD"					2		1		0	
	12/10/2009	"DPD – Simpson Ln."					9				1	
Week 15	12/15/2009	"Narrows – Hwy 20"		1	1		1				0	
	12/16/2009	"Hwy 20 – DPD"					1				0	
	12/17/2009	"DPD – Simpson Ln."	1	1		1	6				2	
Week 16	12/22/2009	"Narrows – Hwy 20"		1			1		1		1	
	12/23/2009	"Hwy 20 – DPD"					1				0	
	12/24/2009	"DPD – Simpson Ln."					8				1	
Week 17	12/29/2009	"Narrows – Hwy 20"					1				1	
	12/30/2009	"Hwy 20 – DPD"					1				0	
	12/31/2009	"DPD – Simpson Ln."									0	
Week 18	1 /5 /2010	"Narrows – Hwy 20"	2	1		1					0	
	1 /7 /2010	"Hwy 20 – DPD"									0	
	1 /8 /2010	"DPD – Simpson Ln."					1				0	
Week 19	1 /12/2010	"Narrows – Hwy 20"									1	
	1 /13/2010	"Hwy 20 – DPD"									0	
	1 /14/2010	"DPD – Simpson Ln."					2	1			0	
Total			200	136	9	34	1218	54	158	34	136	5

Table 2. Coded-wire tag recoveries from decomposed carcasses observed on the lower Yuba River, CA from September 8, 2009 to September 30, 2009.

Head Tag Number	Forklength	Sex	Date Recovered	CWT Code	Assigned Run	Brood Year	Hatchery	Release Location
30014	0	F	29-Sep-09	62338	Spring	2006	Feather R Hatchery	Wickland oil terminal
30016	0	M	29-Sep-09	62314	Fall	2005	Feather R Hatchery	Port Chicago
30017	0	M	29-Sep-09	68014	Spring	2007	Feather R Hatchery	Boyds Pump Ramp
30013	0	M	29-Sep-09	62460	Spring	2005	Feather R Hatchery	SF Bay Contra Costa
30021	0	M	29-Sep-09	62460	Spring	2005	Feather R Hatchery	SF Bay Contra Costa
30023	520	M	30-Sep-09	62476	Spring	2007	Feather R Hatchery	Boyds Pump Ramp
30024	770	F	30-Sep-09	62332	Spring	2006	Feather R Hatchery	Wickland oil terminal
30041	785	F	30-Sep-09	67000	Fall	2006	Feather R Hatchery	San Pablo Bay
30040	615	M	30-Sep-09	62337	Spring	2006	Feather R Hatchery	Feather River
30039	885	M	30-Sep-09	62464	Spring	2005	Feather R Hatchery	SF Bay Selby
30029	765	M	30-Sep-09	62337	Spring	2006	Feather R Hatchery	Feather River
30027	540	F	30-Sep-09	68010	Spring	2007	Feather R Hatchery	Boyds Pump Ramp
30034	570	F	30-Sep-09	68009	Spring	2007	Feather R Hatchery	San Pablo Bay
30035	806	M	30-Sep-09	62337	Spring	2006	Feather R Hatchery	Feather River
74999	490	M	8-Sep-09	68009	Spring	2007	Feather R Hatchery	San Pablo Bay

Table 3. Coded-wire tag number, recovery date, and associated information for adipose fin clipped carcasses observed on the lower Yuba River, CA collected from September 8, 2009 to January 14, 2010.

CWT Number	Date Recovered	Brood Year	Run	Hatchery Origin	CWT Code	Release Location	Sex	Fork Length (mm)
95073	14-Jan-10	2007	Late Fall	Coleman CNFH	52799	Port Chicago	F	745
30076	7-Oct-09	2005	Fall	Feather R Hatchery	62307	West Sacramento	M	930
30081	13-Oct-09	2006	Fall	Feather R Hatchery	62316	West Sacramento	F	762
30062	6-Oct-09	2006	Fall	Feather R Hatchery	62325	Benicia	F	730
95058	23-Oct-09	2006	Spring	Feather R Hatchery	62329	Wickland oil terminal	F	760
30011	29-Sep-09	2006	Spring	Feather R Hatchery	62329	Wickland oil terminal	M	740
30072	7-Oct-09	2006	Spring	Feather R Hatchery	62329	Wickland oil terminal	M	740
30048	6-Oct-09	2006	Spring	Feather R Hatchery	62330	Wickland oil terminal	F	740
30069	7-Oct-09	2006	Spring	Feather R Hatchery	62330	Wickland oil terminal	F	740
74997	13-Oct-09	2006	Spring	Feather R Hatchery	62330	Wickland oil terminal	F	790
30075	7-Oct-09	2006	Spring	Feather R Hatchery	62332	Wickland oil terminal	M	750
74932	21-Oct-09	2006	Spring	Feather R Hatchery	62333	Wickland oil terminal	F	670
30067	7-Oct-09	2006	Spring	Feather R Hatchery	62334	Wickland oil terminal	F	705
30032	30-Sep-09	2006	Spring	Feather R Hatchery	62334	Wickland oil terminal	M	840
30046	6-Oct-09	2006	Spring	Feather R Hatchery	62335	Wickland oil terminal	F	725
30068	7-Oct-09	2006	Spring	Feather R Hatchery	62336	Wickland oil terminal	F	700
30074	7-Oct-09	2006	Spring	Feather R Hatchery	62337	Feather River	F	745
30063	6-Oct-09	2006	Spring	Feather R Hatchery	62337	Feather River	M	665
30077	7-Oct-09	2006	Spring	Feather R Hatchery	62337	Feather River	M	740
30008	22-Sep-09	2006	Spring	Feather R Hatchery	62337	Feather River	M	750
30019	29-Sep-09	2006	Spring	Feather R Hatchery	62337	Feather River	M	780
30044	6-Oct-09	2006	Spring	Feather R Hatchery	62337	Feather River	M	795
30080	13-Oct-09	2006	Spring	Feather R Hatchery	62337	Feather River	M	842
30047	6-Oct-09	2006	Spring	Feather R Hatchery	62338	Wickland oil terminal	F	740
30078	8-Oct-09	2005	Fall	Feather R Hatchery	62449	SF Bay Selby	M	930
30028	30-Sep-09	2005	Spring	Feather R Hatchery	62457	SF Bay Selby	F	790
30033	30-Sep-09	2005	Spring	Feather R Hatchery	62457	SF Bay Selby	M	951
30009	29-Sep-09	2005	Spring	Feather R Hatchery	62459	SF Bay Selby	F	840
30006	22-Sep-09	2005	Spring	Feather R Hatchery	62462	Feather River	M	1000
30026	30-Sep-09	2005	Spring	Feather R Hatchery	62463	SF Bay Contra Costa	F	860
30038	30-Sep-09	2005	Spring	Feather R Hatchery	62466	SF Bay Selby	M	940
30043	1-Oct-09	2005	Spring	Feather R Hatchery	62467	SF Bay Contra Costa	F	890
30065	7-Oct-09	2007	Spring	Feather R Hatchery	62475	Boyds Pump Ramp	M	560
30007	22-Sep-09	2007	Spring	Feather R Hatchery	62475	Boyds Pump Ramp	M	570
30045	6-Oct-09	2006	Fall	Feather R Hatchery	67000	San Pablo Bay	F	745
74935	21-Oct-09	2006	Fall	Feather R Hatchery	67000	San Pablo Bay	F	785
74929	16-Sep-09	2006	Fall	Feather R Hatchery	67000	San Pablo Bay	M	735
30070	7-Oct-09	2006	Fall	Feather R Hatchery	67002	San Pablo Bay	M	910
95056	22-Oct-09	2006	Fall	Feather R Hatchery	67002	San Pablo Bay	M	790
95068	4-Nov-09	2006	Fall	Feather R Hatchery	67005	San Pablo Bay	F	765
30042	1-Oct-09	2007	Fall	Feather R Hatchery	67016	San Pablo Bay	M	500
30015	29-Sep-09	2007	Fall	Feather R Hatchery	67016	San Pablo Bay	M	535
74930	13-Oct-09	2007	Fall	Feather R Hatchery	67016	San Pablo Bay	M	590
95065	28-Oct-09	2006	Fall	Feather R Hatchery	67018	San Pablo Bay	F	700
95059	23-Oct-09	2006	Fall	Feather R Hatchery	67019	San Pablo Bay	F	765
30030	30-Sep-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	F	540
30022	29-Sep-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	460

Table 3 (continued). Coded-wire tag number, recovery date, and associated information for adipose fin clipped carcasses observed on the lower Yuba River, CA collected from September 8, 2009 to January 14, 2010.

CWT Number	Date Recovered	Brood Year	Run	Hatchery Origin	CWT Code	Release Location	Sex	Fork Length (mm)
30020	29-Sep-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	490
30071	7-Oct-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	550
30031	30-Sep-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	562
30049	6-Oct-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	575
30073	7-Oct-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	595
30036	30-Sep-09	2007	Spring	Feather R Hatchery	68009	San Pablo Bay	M	605
30012	29-Sep-09	2007	Spring	Feather R Hatchery	68010	Boyds Pump Ramp	F	570
30079	13-Oct-09	2007	Spring	Feather R Hatchery	68010	Boyds Pump Ramp	M	540
30064	6-Oct-09	2007	Spring	Feather R Hatchery	68010	Boyds Pump Ramp	M	595
30066	7-Oct-09	2007	Spring	Feather R Hatchery	68012	Boyds Pump Ramp	F	550
30061	6-Oct-09	2007	Spring	Feather R Hatchery	68015	Boyds Pump Ramp	M	455
95070	10-Nov-09	2007	Fall	Mokelumne R Fish Ins	68601	San Pablo Bay	M	570
95072	3-Dec-09	2007	Fall	Nimbus Fish Hatchery	68602	San Pablo Bay	M	600
95062	23-Oct-09	2007	Fall	Feather R Hatchery	68604	San Pablo Bay	M	590
95061	23-Oct-09	2007	Fall	Feather R Hatchery	68608	San Pablo Bay	M	570
95055	22-Oct-09	2007	Fall	Feather R Hatchery	68608	San Pablo Bay	M	630
95054	22-Oct-09	2007	Fall	Feather R Hatchery	68609	San Pablo Bay	F	580
74933	21-Oct-09	2007	Fall	Feather R Hatchery	68609	San Pablo Bay	M	610
74995	15-Oct-09	2007	Fall	Feather R Hatchery	68609	San Pablo Bay	M	610
74936	21-Oct-09	2007	Fall	Feather R Hatchery	68609	San Pablo Bay	M	625
30082	13-Oct-09	2007	Fall	Feather R Hatchery	68610	San Pablo Bay	M	509
30010	29-Sep-09	2007	Fall	Feather R Hatchery	68610	San Pablo Bay	M	520
95051	14-Oct-09	2007	Fall	Feather R Hatchery	68610	San Pablo Bay	M	582
95060	23-Oct-09	2007	Fall	Feather R Hatchery	68610	San Pablo Bay	M	590
74951	15-Oct-09	2007	Fall	Feather R Hatchery	68610	San Pablo Bay	M	600
74931	13-Oct-09	2007	Fall	Feather R Hatchery	68610	San Pablo Bay	M	625
95069	10-Nov-09	2007	Fall	Feather R Hatchery	68611	San Pablo Bay	F	600
95066	28-Oct-09	0			100000		F	540
95071	12-Nov-09	0			100000		F	705
95067	4-Nov-09	0			100000		F	755
95057	22-Oct-09	0			100000		F	820
95052	14-Oct-09	0			100000		M	819
30018	29-Sep-09	0			100000		F	920
74985	14-Oct-09	0			100000		F	725
95050	14-Oct-09	0			100000		F	889
95063	23-Oct-09	2006	Fall	Coleman CNFH	501040805	Clarksburg	M	900
95064	27-Oct-09	2006	Fall	Coleman CNFH	501040806	Clarksburg	F	830
95053	14-Oct-09	2006	Fall	Feather R Hatchery	601090105	Yolo Bypass	M	929
30037	6-Oct-09	2006	Fall	Feather R Hatchery	601090107	Yolo Bypass	M	845
74934	21-Oct-09	2006	Fall	Feather R Hatchery	601090205	Elkhorn Boat Ramp	F	730

CWT Code 100000 indicates that no tag was detected.

Table 4. Hatchery of origin for coded-wire tag recoveries observed on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

Hatchery	Count	Percentage
Feather River	74	85.06%
Coleman CNFH	3	3.45%
Mokelumne	1	1.15%
American River	1	1.15%
Tag Not Detected	8	9.20%
Total	87	100.00%

Table 5. Brood year, count, percent fraction, and run assignments by brood year for all coded-wire tag recoveries observed on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

All Fresh CWTs Collected			Spring		Fall		Late Fall		TND	
Brood Year	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
2005	9	10.34%	7	8.05%	2	2.30%	0	0.00%		
2006	35	40.23%	20	22.99%	15	17.24%	0	0.00%		
2007	35	40.23%	15	17.24%	19	21.84%	1	1.15%		
Tag Not Detected	8	9.20%							8	9.20%
Total	87	100.00%	42	48.28%	36	41.38%	1	1.15%	8	9.20%

Table 6. Release location, count, and percent fraction of all fresh coded-wire tag recoveries observed on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

Release Location	Count	Percent
Benicia	1	1.15%
Clarksburg	2	2.30%
Elkhorn Boat Ramp	1	1.15%
Feather River/Boyds pump ramp	15	17.24%
Port Chicago	1	1.15%
San Pablo Bay	35	40.23%
SF Bay Contra Costa	2	2.30%
SF Bay Selby	5	5.75%
West Sacramento	2	2.30%
Wickland oil terminal	13	14.94%
Yolo Bypass	2	2.30%
Tag Not Detected	8	9.20%
	87	100.00%

Table 7. Modified-Schaefer matrix used to estimate adult Chinook salmon abundance in the lower Yuba River, CA from September 8, 2009 to January 14, 2010 including adjustment for proportional grilse fraction.

SURVEY PERIOD	T(i) NUMBER TAGGED	NUMBER CHOPPED	RATIO E(i)/R(i)	E(i) TOTAL EXAMINED	R(i) Sum of Rows RECOVERED		RECAPTURES OF FISH MARKED IN SURVEY PERIOD														
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8-Sep	2	0	0	2	0																
15-Sep	2	2	0	6	0		0														
22-Sep	9	5	15	15	1			1													
29-Sep	39	55	32.3333	97	3				3												
6-Oct	68	149	15.4667	232	15					15											
13-Oct	64	185	15.6471	266	17						17										
20-Oct	43	336	15.5769	405	26					1	9	16									
27-Oct	33	185	17.7692	231	13							3	10								
3-Nov	22	142	7.56	189	25					1	2	6	4	12							
10-Nov	19	68	9.7	97	10								1	2	7						
17-Nov	8	59	8.44444	76	9							1	1	1	2	4					
24-Nov	15	26	9.2	46	5										2	1	2				
1-Dec	5	24	8.25	33	4									1	0	1	1	1			
8-Dec	0	12	7	14	2											1	0	0	1		
15-Dec	3	8	6.5	13	2														2	0	
22-Dec	1	10	6.5	13	2																2
29-Dec	0	2	3	2.999999	0.999999																
5-Jan	3	1	0	4	0																
12-Jan	0	3	4	4	1																
Totals	336	1272		1746	135.999999	R(i) Total															
					135.999999	C(i) Total															
				C(i) RECOVERED Sum of Columns			0	1	3	17	28	26	16	16	11	7	3	1	3	0	2
				T(i) / C(i) Ratio			0.00	2.00	3.00	2.29	2.43	2.46	2.69	2.06	2.00	2.71	2.67	15.00	1.67	0.00	1.50

RECAPTURES OF FISH MARKED IN SURVEY PERIOD				
16	17	18	19	
1	0	1	0	
1.00	0.00	3.00	0.00	

SCHAEFER ESTIMATE CALCULATIONS:	
Total Population from Matrix =	4,326
# Tagged from period 2 to last =	-334
SCHAEFER ESTIMATE IS:	3,992
Grilse Proportion from Matrix =	803
Total Estimate =	4,795

Matrix of Population Estimates

Survey Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
8-Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15-Sep	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Sep	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Sep	0	0	291	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	0	0	0	532	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	0	0	0	0	646	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	0	0	0	36	340	613	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	0	0	0	0	0	131	478	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	0	0	0	17	37	112	81	187	0	0	0	0	0	0	0	0	0	0	0
10-Nov	0	0	0	0	0	0	26	40	136	0	0	0	0	0	0	0	0	0	0
17-Nov	0	0	0	0	0	21	23	17	34	92	0	0	0	0	0	0	0	0	0
24-Nov	0	0	0	0	0	0	0	0	37	25	49	0	0	0	0	0	0	0	0
1-Dec	0	0	0	0	0	0	0	17	0	22	22	124	0	0	0	0	0	0	0
8-Dec	0	0	0	0	0	0	0	0	0	19	0	0	12	0	0	0	0	0	0
15-Dec	0	0	0	0	0	0	0	0	0	0	0	0	22	13	0	0	0	0	0
22-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0
29-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
5-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
12-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0
Totals	6	30	291	585	1023	877	608	262	206	158	71	124	33	13	20	3	4	12	0

Table 8. Length distributions and descriptive statistics for all fresh Chinook salmon carcasses observed (female adipose fin clipped, female adipose fin present, male adipose fin clipped, male adipose fin present) on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

	All	Female			Male		
		All	Ad-Clipped	Ad-Present	All	Ad-Clipped	Ad-Present
Count	466	245	36	209	221	51	170
Mean	788.40	782.27	734.61	790.48	795.19	681.06	829.44
Median	795	780	742.5	790	840	610	861
Mode	740	790	745	790	910	740	910
Standard Error	5.83	5.17	16.08	5.20	10.87	21.05	11.43
Standard Deviation	125.84	80.96	96.48	75.24	161.59	150.33	148.98
Minimum	455	540	540	560	455	455	505
Maximum	1130	960	920	960	1130	1000	1130
CV	0.16	0.10	0.13	0.10	0.20	0.22	0.18
CI (95%)	11.46	10.19	32.65	10.26	21.42	42.28	22.56

Table 9. Annual abundance estimates for natural spawning fall-run Chinook salmon in California Central Valley anadromous waters from 1994-2009.

	Sacramento River Mainstem	Battle Creek	Clear Creek	Cottonwood Creek	Cow Creek	Bear Creek	Mill Creek	Deer Creek	Butte Creek	Feather River	Yuba River	American River	Cosumnes River	Mokelumne River	Stanislaus River	Tuolumne River	Merced River
1994	44,729	24,274	2,546				1,081	307		38,382	10,890	31,520		1,238	1,031	506	2,646
1995	53,385	56,515	9,298						445	59,912	14237*	80,330		2,194	619	827	2,320
1996	71,725	52,409	5,922						500	57,170	27,900	74,745		4,038	168	4,362	3,291
1997	98,765	50,744	8,569				478	1,203	800	50,547	25,948	52,195		3,681	5,588	7,146	2,714
1998	5,718	53,957	4,259				546	270	500		31,090	54,792	300	4,122	3,087	8,910	3,292
1999	133,365	92,929	8,003								24,230	55,339	229	2,183	4,349	8,232	3,129
2000	87,793	53,447	6,687							114,717	14,995	99,059	460	1,973	8,498	17,873	11,130
2001	57,792	100,604	10,865						4,433	178,645	23,392	135,384		2,307	7,033	8,782	9,181
2002	45,523	397,149	16,071				2,611		3,665	105,163	24,051	124,252	1,350	2,840	7,787	7,173	8,866
2003	66,476	64,764	9,475				2,426		3,492	89,946	28,316	163,742	122	2,122	5,902	2,163	2,530
2004	34,050	23,861	6,365				1,192	300	2,516	54,171	15,269	99,230	1,208	1,588	4,015	1,984	3,270
2005	44,950	20,520	14,824				2,426	946	4,255	48,586	17,630	56,843	370	10,406	3,315	719	1,921
2006	46,568	19,493	8,422		4,130		1,403	1,905	1,920	75,430	8,231	22,900	530	1,732	1,923	625	1,470
2007	14,097	9,904	4,129	1,250	2,044	140	796	508	1,225	21,862	2,604	9,985	77	470	443	224	495
2008	23,149	4,290	7,677	200	200	20	166	194	275	5,939	3,508	2,742	15	173	1,392	372	389
2009	5,827	3,047	3,228	1,055	261	6	102	58	306	4,847	4,795	5,297	0	680	595	124	358

* Survey methods not comparible. Estimate includes assumed 15.5% contribution to annual escapement from Rose Bar to SR20 Bridge.

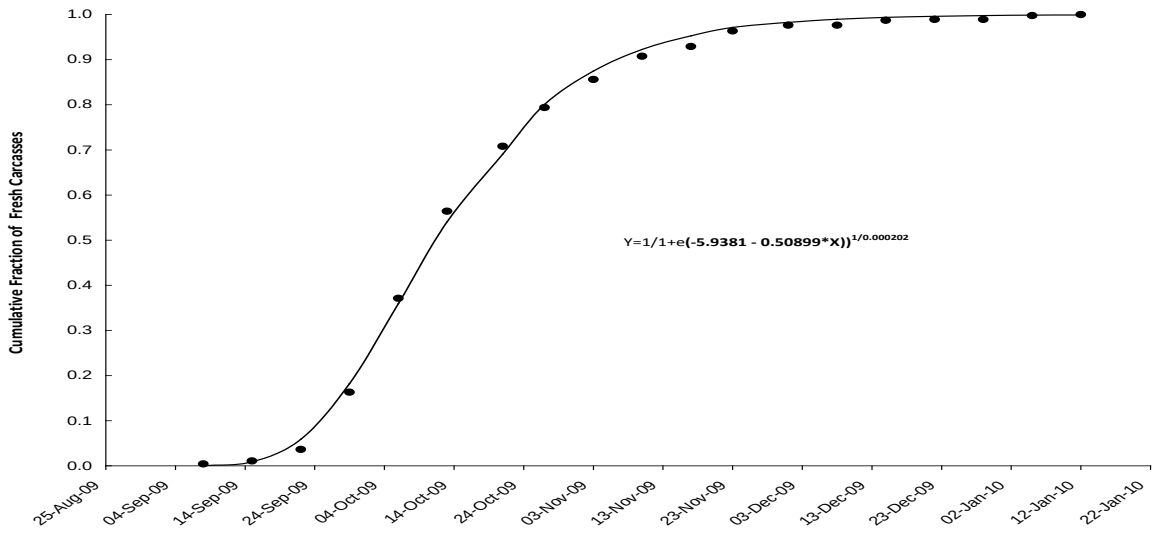

Figure 1. Cumulative fraction of fresh Chinook salmon carcasses observed by date in the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

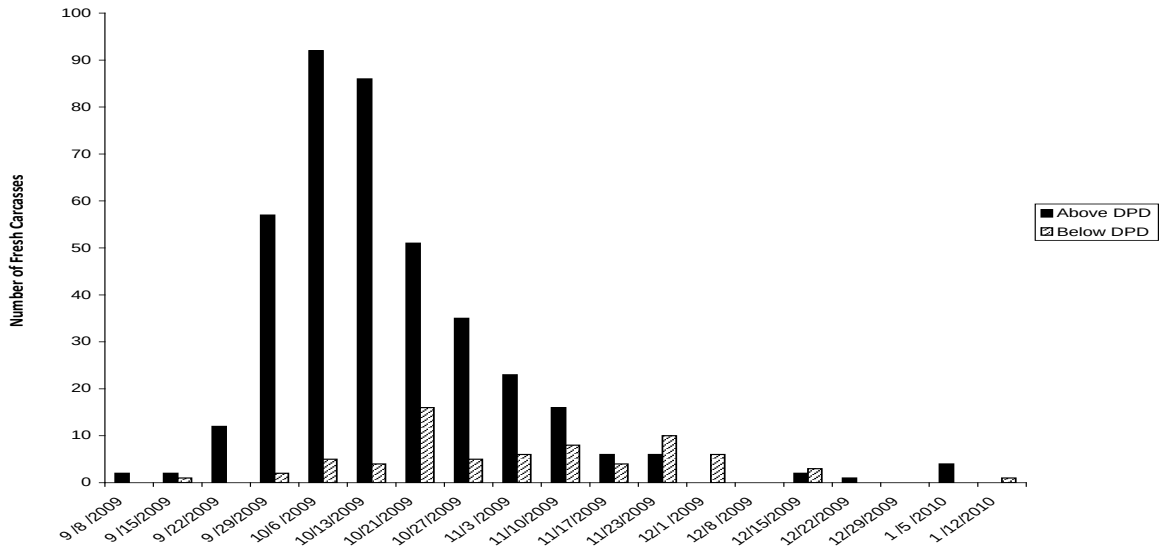

Figure 2. Frequency distribution of fresh Chinook salmon carcasses observed above and below Daguerre Point Dam in the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

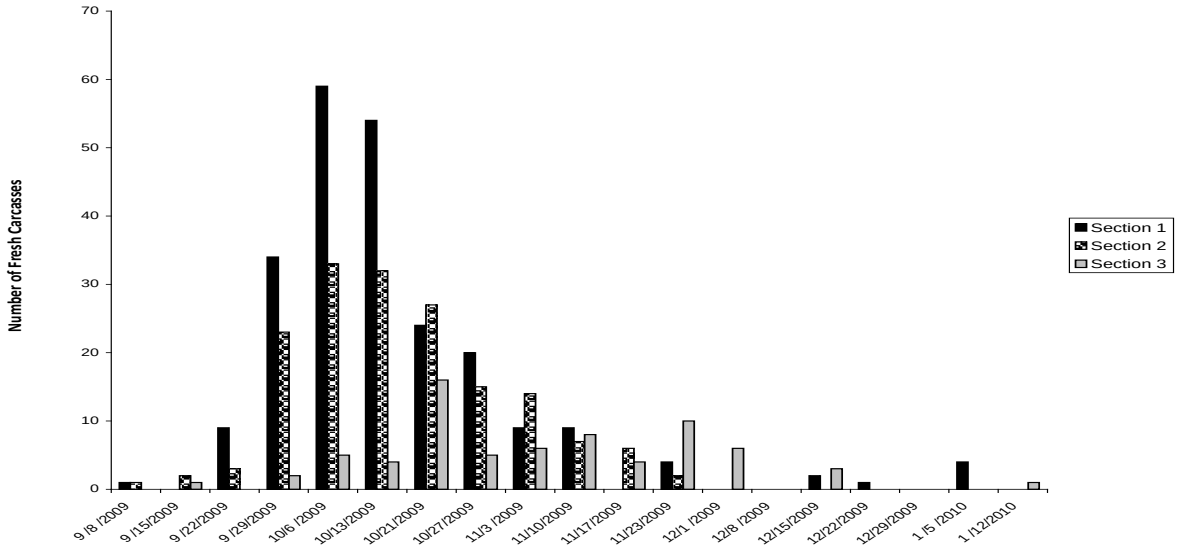

Figure 3. Temporal distribution of fresh Chinook salmon carcasses in the lower Yuba River, CA as observed from the Narrows Pool to the State Route 20 Bridge (Section 1), from the State Route 20 Bridge to Daguerre Point Dam (Section 2), and from Daguerre Point Dam to Simpson Lane Bridge (Section 3) from September 8, 2009 to January 14, 2010.

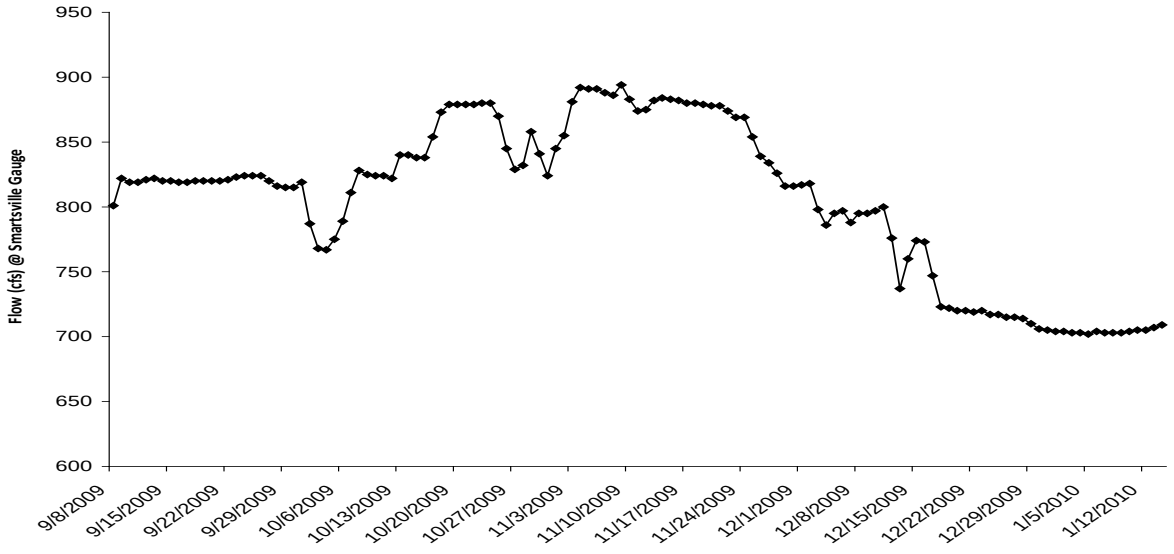

Figure 4. Mean daily flow (cfs) of the lower Yuba River measured at the U.S. Geological Survey gage at Smartsville, CA from September 8, 2009 to January 14, 2010.

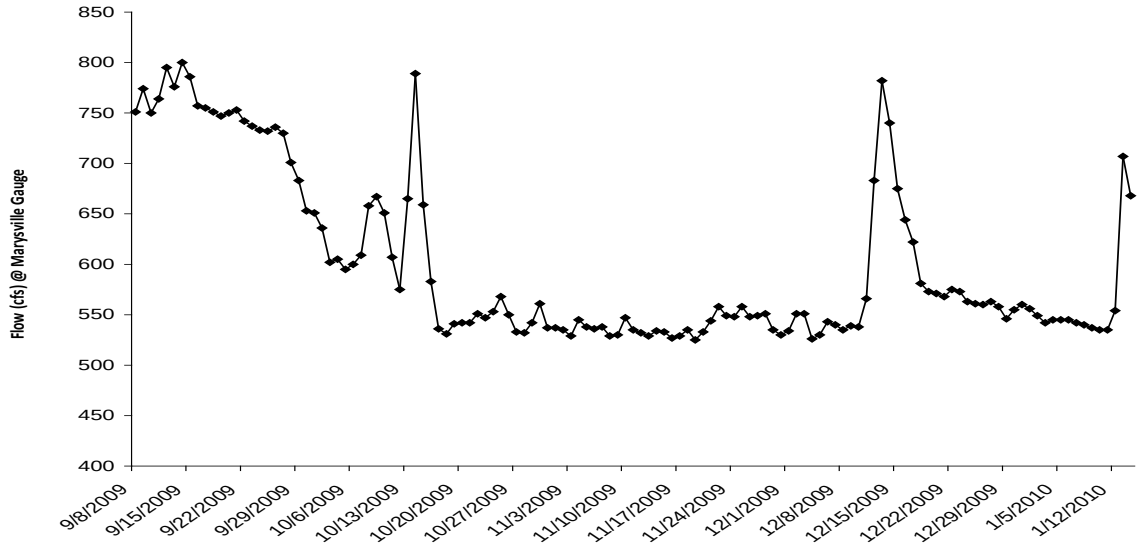

Figure 5. Mean daily flow (cfs) in the lower Yuba River measured at the U.S Geological Survey gage at Marysville, CA from September 8, 2009 to January 14, 2010.

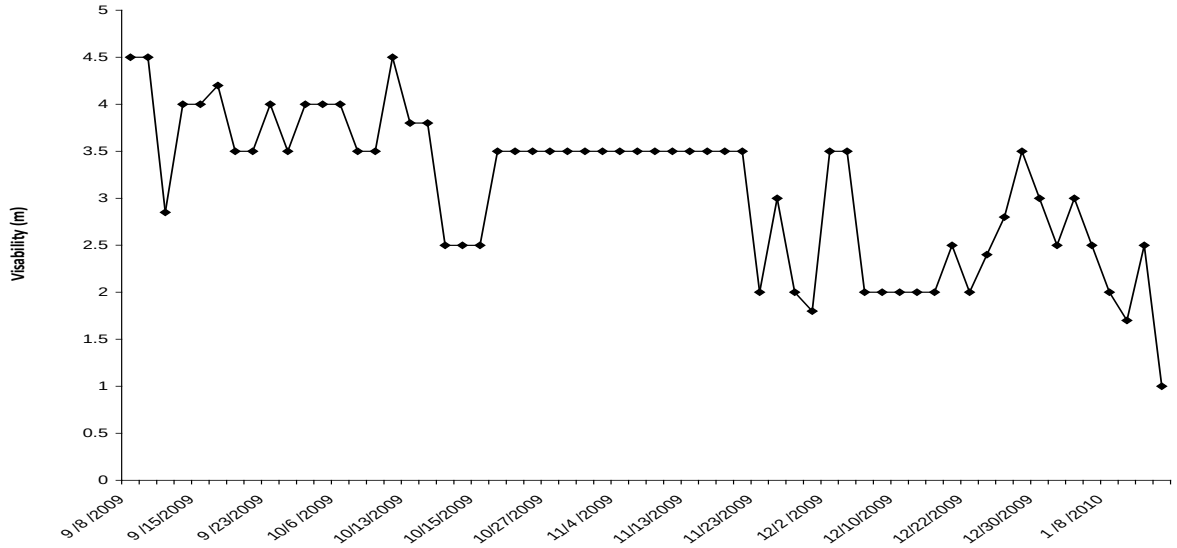

Figure 6. Secchi disk depth observations measured in meters of visibility on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

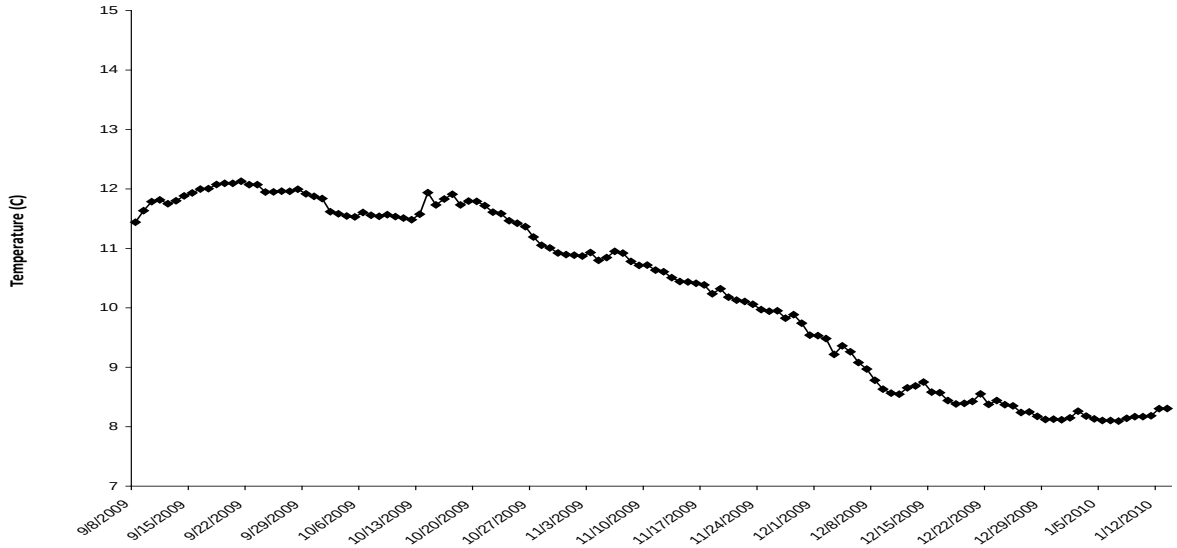

Figure 7. Mean daily water temperature (°C) in the lower Yuba River, CA measured at the U.S. Geological Survey Smartsville gage from September 8, 2009 to January 14, 2010.

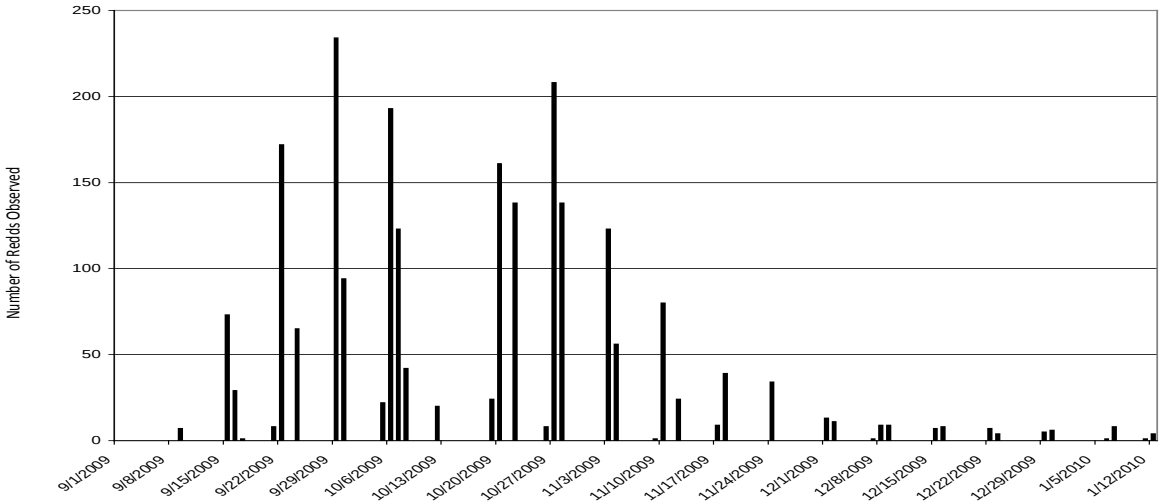

Figure 8. Chinook salmon redd observations above Daguerre Point Dam on the lower Yuba River, CA from September 1, 2009 through January 12, 2010.

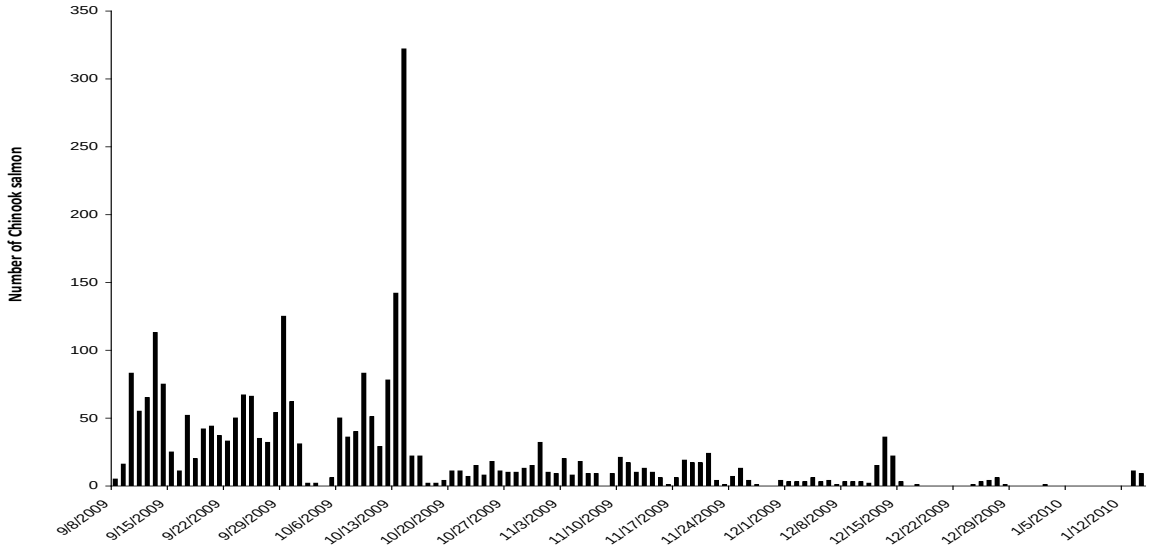

Figure 9. Frequency of Chinook salmon net passage at Daguerre Point Dam (North and South ladders) on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

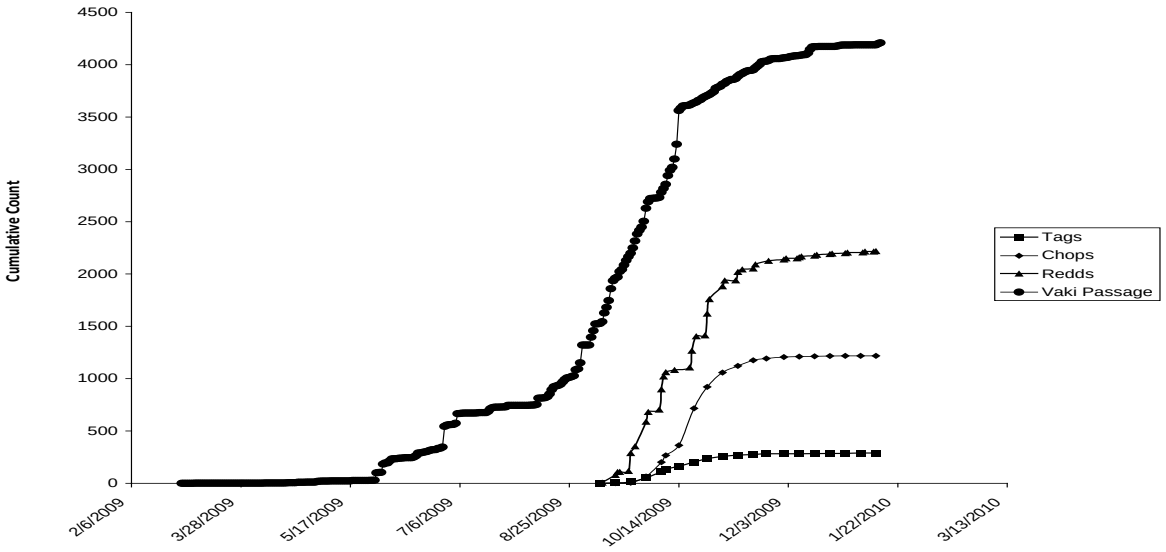

Figure 10. Cumulative Chinook salmon passage from Vaki Riverwatcher data, fresh carcass observations and redds observed above Daguerre Point Dam on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

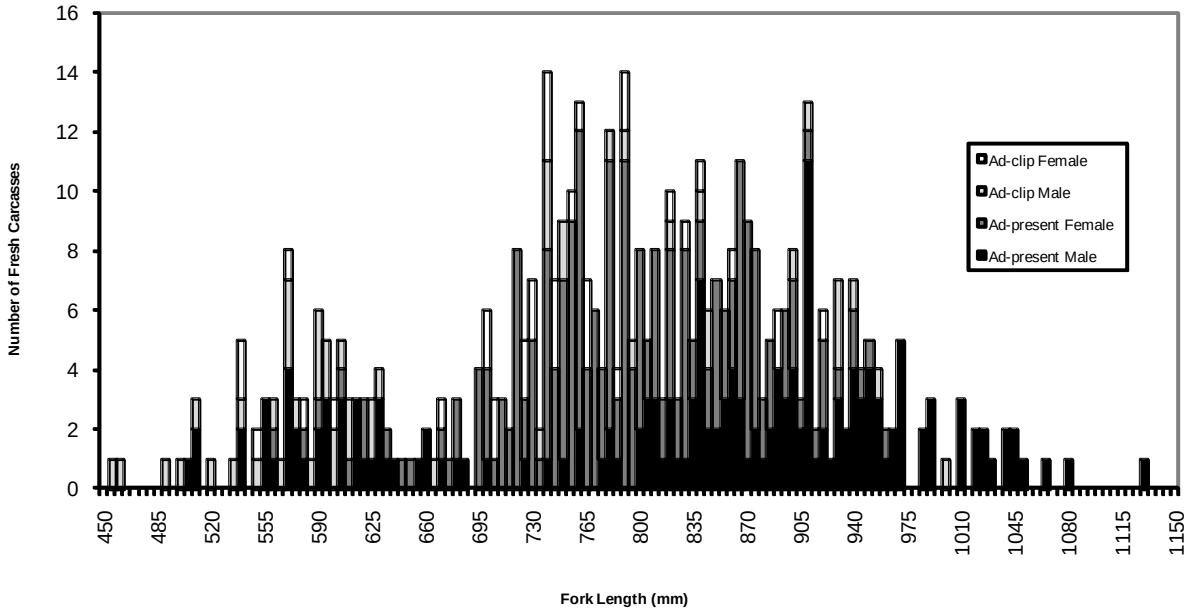

Figure 11. Length-frequency distribution for all fresh Chinook salmon carcasses (adipose clipped females, adipose clipped males, adipose present females and adipose present males) observed on the lower Yuba River, CA from September 8, 2009 to January 14, 2010.

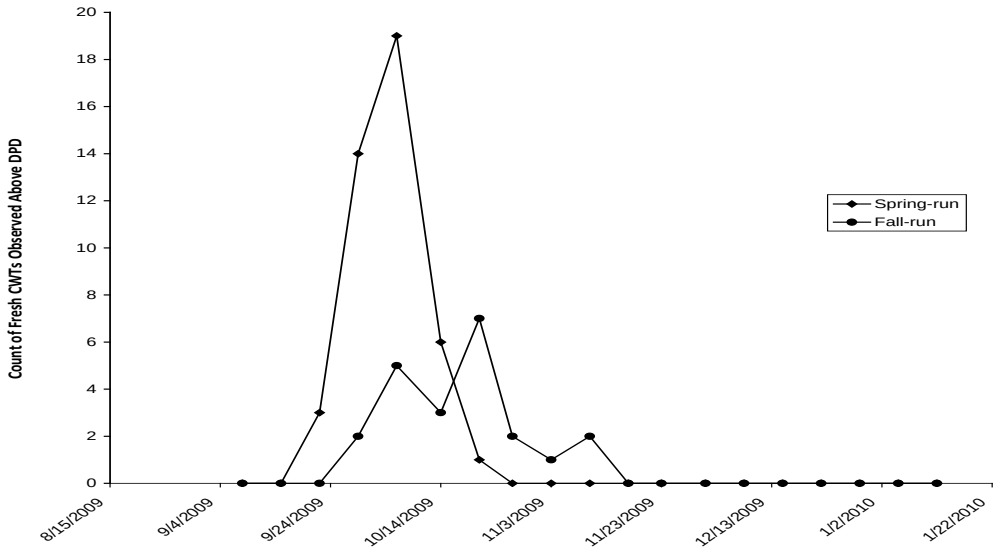

Figure 12. Temporal distribution of CWT collections on the lower Yuba River, CA with run assignments from September 8, 2009 to January 14, 2010.