# LOWER YUBA RIVER ACCORD MONITORING AND EVALUATION PLAN

## ANNUAL VAKI RIVERWATCHER REPORT

MARCH 1, 2007 – FEBRUARY 29, 2008

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## 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 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.

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

The RMT is conducting studies through 2016 to obtain data needed for the M&E Plan. Infrared-imaging technology was used to monitor fish passage at Daguerre Point Dam (DPD) in the lower Yuba River using Vaki Riverwatcher systems to document specific observations addressing VSP parameters of adult abundance and diversity. The Vaki Riverwatcher infrared systems produced by Vaki Aquaculture Systems Ltd., of Iceland, provide a tool for monitoring fish passage year-round without need for continuous video feeds. The Vaki Riverwatcher system records both silhouettes and electronic images of each fish passage event. By capturing silhouettes and images, fish passage can be accurately monitored even in under turbid conditions. Monitoring objectives[2] included: (1) abundance estimation of spring-, fall-, and late fall-run Chinook salmon and steelhead trout[3] above DPD;, (2) abundance estimation of steelhead trout below DPD;, (3) identification of temporal distributions of immigrating spring-, fall-, and late fall-run Chinook salmon and steelhead trout above DPD;, (4) identify population-level diversity from length-frequency distributions for Chinook salmon and steelhead trout;, (5) identify the age structure of Chinook salmon and steelhead trout populations from observed length-frequency distributions;, (6) examine annual and multi-year trends in the temporal periodicity of immigrating Chinook salmon and steelhead trout above DPD;, and (7) evaluation of potential relationships between water temperature, flow, and the timing of adult salmonid immigration.

## Methods

*Survey Period, Survey Location, Data Collection Methods*

The Vaki Riverwatcher systems were operated and maintained in strict accordance with protocols and procedures (*Appendix F – Specific sampling protocols and procedures for Vaki Riverwatcher monitoring*). The minimum body depth recorded by the Vaki systems is 4.0 cm.

The survey period for Chinook salmon and steelhead trout was defined as March 1, 2007 through February 29, 2008.

*Data Analysis Methods*

<u>Vaki Riverwatcher Operation</u>

Vaki Riverwatcher system operation was described by examining the range of dates each system operated and comparing those dates with the total possible days of operation. Vaki system non-operation events were classified by one of three categories; low-voltage disconnections (LVD), system maintenance or unknown malfunctions.

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[2] The objectives as stated follow the M&E Plan and VSP conceptual architecture, but specific analytic measures pertaining to abundance in the M&E Plan (e.g. corrections for missing data and estimation of steelhead trout abundance below DPD) were beyond the scope of this annual report. See discussion on page 9.

[3] Steelhead trout refers to the species, *Oncorhynchus mykiss,* regardless of anadromous or resident life-history.

Fish Community

The net passage and percent of total passage at DPD by each fish species was calculated. In addition, the relative percent passage at the North and South fish ladders was calculated for each species and for the total passage of all species.

Abundance

Total net upstream passage for Chinook salmon from all categories (adipose fin clipped, adipose fin present, and adipose fin undetermined) and steelhead trout was estimated by summing daily net passage for the survey period (March 1, 2007 - February 29, 2008). Total net upstream passage was defined as the total number of Chinook salmon or steelhead trout that migrated upstream minus the total number of migrants that moved downstream. The presence of an adipose fin clip was not examined for steelhead trout, as the Vaki systems did not provide sufficient image resolution for identification of morphological characters for this species.

Diversity

Relationships between temporal periods of passage at DPD for Chinook salmon and steelhead trout were examined in conjunction with water temperature and flow. The frequency of passage was plotted with water temperature and flow measurements obtained at the Smartsville (CDEC station “YRS”) and Marysville (CDEC station “MRY”; USGS 11421000) gages.

A frequency histogram of daily net upstream passage of Chinook salmon and steelhead trout passing DPD was developed to examine temporal distributions. The daily fraction of operation for the Vaki systems was calculated by dividing the total number of hours of available operation (48 hours; 24 hours for each of two systems) by the total number of hours the systems operated.

A scatter-plot of the cumulative distribution of the net upstream passage of Chinook salmon and steelhead trout above DPD was developed for the study period – March 1, 2007 through February 29, 2008. A generalized logistic function (Richards 1959) was used to describe the relationship:

$$\sum_{i=1}^{Di=n} Y_i = \left( \frac{1}{1 + \exp(\alpha + \beta \times D_i)} \right)^{\frac{1}{\delta}};$$

Where $\sum_{i=1}^{Di=n} Y_i$ is the net passage of Chinook salmon or steelhead trout upstream of DPD from the start of the survey period through the end of the survey period $D_i$; and $\alpha$, $\beta$, and $\delta$ are parameters that describe the shape of the resulting logistic function.

The size structure of all Chinook salmon categories (adipose fin present, adipose fin clipped and adipose fin undetermined) and steelhead trout was examined using length-frequency histograms and descriptive statistics from net passage observations. A sample mean with 95% confidence intervals was used to describe the central tendency of observed lengths.

The net upstream passage and proportion of Chinook salmon adults and grilse was calculated. Chinook salmon grilse were defined as having a total length < 65 cm. This length has been used to separate grilse from adults in the lower Yuba River since 1997 (Jones & Stokes 1998) and has also been identified from Feather River Hatchery spawning data.

Modal distributions of length frequency were examined to describe the age structure of Chinook salmon and steelhead trout populations. Data were separated for adipose fin clipped and non-clipped Chinook salmon. Minimum, mean, and maximum length (cm) was calculated for each age class. Length-frequency distributions for Chinook salmon were compared with known age-class distributions observed from escapement survey scale age data.

## Results

Operation of Vaki Riverwatcher Systems

The Vaki Riverwatcher systems operated semi-continuously for 366 days from March 1, 2007 through February 29, 2008. The North and South units operated for 329 and 311 days, respectively. The North system experienced 34 separate system failure events during the survey period. The maximum number of continuous monitoring days for the North system was 54 (March 1 to April 23). The South system observed 57 days of continuous monitoring (October 30 to December 16), resulting from 45 separate system failures.

Vaki Riverwatcher systems were frequently inoperable during January 2008; operating approximately 12 of 31 available days (40.1%) because of LVD. The systems experienced other periods of non-operation, but were online for the most of the sample period (Table 1). The combined percentage of online status for both units was 87.4%.

Fish Community Composition

Chinook salmon comprised the majority of net upstream passage recorded by the Vaki Riverwatcher systems (32.2%). Steelhead trout represented 17.0%, whereas Sacramento sucker (16.0%), Sacramento pikeminnow (4.6%), hardhead (1.1%) and unidentified species (29.1%) accounted for the remainder of the sample (Table 2). The North system accounted for 75% of the total passage at DPD observed for all species (Table 2).

Abundance

Total net upstream passage from March 1, 2007 through February 29, 2008 of Chinook salmon and steelhead trout above DPD was 1,324 and 698, respectively. Of the 1,324 Chinook salmon, 1,219 (92%) had an adipose fin and 63 (5%) were adipose fin clipped. The presence of an adipose fin could not be determined for 42 (3%) of the observed sample (Table 2).

Diversity

The majority of net upstream passage of Chinook salmon was observed from mid-October through mid-November 2007 (Table 2). Chinook salmon were additionally observed migrating above DPD during all months of the sample period (Figure 1). Chinook salmon observations were divided into two temporal periods of passage (March 1, 2007 - August 31, 2007 and

September 1, 2007 - February 28, 2010) in order to develop logistic functions representing the two distinct modes of Chinook salmon passage observed at DPD.

Steelhead trout were also observed migrating upstream of DPD during all months of the sample period (Figure 2). The majority of steelhead trout were observed from March 2007 through June 2007 (Table 2), with fewer observed from July 2007 through August 2007. The peak migration occurred during the months of May 2007 and June 2007. Observations of steelhead trout were the lowest during September 2007. Steelhead trout numbers were also low from October 2007 through January 2008, but increased in February 2008.

Chinook salmon from all categories (adipose fin present, adipose fin clipped and adipose fin undetermined) ranged in length from 20 cm to 111 cm (Figure 3). The average length was 82 cm (±0.75 cm; 95% CI) and median length was 83 cm (Table 3). The most frequently observed length was 79 cm.

Chinook salmon with an adipose fin present ranged in length from 20 cm to 111 cm. The length-frequency distribution is similar to that observed for all Chinook salmon (Figure 3). The average length was 83 cm (±0.74 cm; 95% CI) and median length was 84 cm (Table 3). The most frequently observed length was 79 cm.

Chinook salmon with an adipose fin clip ranged in length from 43 cm to 100 cm. The average length was 76 cm (±2.83 cm; 95% CI) and median length was 78 cm (Table 3). The most frequently observed length was 74 cm.

The net fraction of all upstream migrating Chinook salmon above DPD identified as adults (≥ 65 cm) represented 91.1% of the total passage, whereas grilse accounted for 8.9%. Observations of adult and grilse Chinook salmon in each independent category followed similar distributions. Adults comprised 92.9% and 90.5% of the distributions for Chinook salmon that were adipose fin clipped and adipose fin undetermined, respectively.

Steelhead trout length ranged from 18 cm to 76 cm (Figure 4). The average length was 27 cm (±0.77 cm 95% CI) and median length was 23 cm (Table 3). The most observed length was 18 cm.

## Discussion

The Vaki Riverwatcher systems were able to record and identify the timing and magnitude of passage for multiple species at DPD during most temporal periods, although system failures reduced the ability of the equipment to document ladder use during some months. Most system failures were caused by low-volt disconnects (LVD). LVD events occurred when the electrical demands of the Vaki Riverwatcher systems exceeded photovoltaic power generation and/or storage (e.g. system voltage dropped below 11.7 volts). The units were also occasionally disconnected for maintenance by fishery technicians (e.g. battery recharging, camera lens cleaning, etc.). Other malfunctions were observed in which no direct explanations for system disconnect could be diagnosed.

LVD often affected system operation during the winter months as a result of low photovoltaic power generation and a lack of capacity to store sufficient power to bridge periods of low photoperiod. In contrast, LVD were observed less frequently during the fall months (September – November), but other unidentified malfunctions resulted in system downtime during this period. Although the definitive causes of these unidentified system malfunctions were unknown, the periods of non-operation were suspected to be the result of data processing limitations. Multiple sustained passage events that coincided with peak fall-run Chinook salmon immigrations are thought to have exceeded the system's data processing capabilities. These unknown malfunctions ultimately resulted in multiple lapses of data continuity.

The Vaki systems at DPD were inoperable during much of January due to LVD, potentially obscuring observations of steelhead trout passage. Data gaps caused by LVD were compounded by high water turbidity during winter storm flow events. Surface runoff during winter storms often increased the level of suspended solids in the water column and decreased digital image resolution due to particle light reflection or backscatter. Although Chinook salmon can generally be identified from silhouettes alone, positive steelhead trout identification required both a silhouette and a clear digital image. Digital image resolution was insufficient for positive steelhead trout identification during turbid winter flows and many passage events during this period were classified as unidentified. Additionally, downstream steelhead trout movement can only provide silhouettes without associated digital images, so downstream movements are also often categorized as unidentified fish[4]. These steelhead trout identification limitations compounded existing system failures and hampered efforts to quantify Chinook salmon runs (i.e., spring-, fall-, and late fall-run), as well as to identify steelhead trout during known periods of passage. Linear interpolation has been suggested as a useful method to fill data gaps, but this estimation procedure was not performed in this report. System failures during peak Chinook salmon and steelhead trout passage periods may have resulted in a truncation of observed versus actual asymptotic peaks. Davies *et al.* (2007) found that linear interpolation under this scenario exhibited substantial bias. Data presented in this report represent minimum passage for all species until data quality is improved or more sophisticated methods are developed to correct for missing data.

Despite these data limitations, the Vaki Riverwatcher systems provided observations supporting many M&E Plan analytics, and supported data collected from other Yuba River Chinook salmon and steelhead trout studies including the annual escapement estimates from mark-recapture surveys. The total net passage estimate from the Vaki Riverwatchers for Chinook salmon in 2007 (1,324) was exceedingly low as compared to previous Vaki Riverwatcher records (CDFG, unpublished data). The escapement estimate for Chinook salmon of 2,604 spawners was also lower than the historical 1998-2008 average of 17,574 (max 31,090; min 2604) in the lower Yuba

[4] Does not include Chinook salmon. Chinook salmon are identifiable solely from silhouettes.

River. Additionally, the 2007 lower Yuba River escapement estimate was the lowest recorded since 1994 (Massa 2008) and the lowest recorded in GrandTab[5] since 1957.

Migration timing and modal passage distributions in the lower Yuba River were also consistent with observations of spring- and fall-run Chinook salmon from this, and other Central Valley rivers. Chinook salmon exhibiting spring-run phenotypic characteristics (i.e. early run timing, sexually undifferentiated, relatively small body size, etc.) were first observed migrating above DPD in March 2007. The distribution identified by this temporal period was marked by a modal peak during the last week in May 2007 and seemed to model previous observations of spring-run Chinook salmon run-timing from the lower Yuba River and other Central Valley rivers. Spring-run Chinook salmon upstream migrations have been observed to peak in April and May in the upper Sacramento River and lower Yuba River (SWRI 2002; Vogel and Marine 1991), and have also been observed to occur in Mill Creek from March to June with peak passage during the last week of April (Killam and Johnson 2008). Additionally, Yoshiyama *et al*. (2001) described spring-run migration to occur from April through June in the Sacramento River drainage.

A second modal peak of passage for Chinook salmon was observed at DPD during the last week of October. These two peak passage events likely represent separate runs of spring- and fall-run Chinook salmon, respectively. Peak migration timing for fall-run Chinook salmon in Cottonwood Creek and Cow Creek during 2007 occurred during the second week in October, and the overall fall-run migration period was identified to span from September through December of the same calendar year (Killam 2008a and 2008b) and from July through December in most Central Valley streams (NMFS 2004; Vogel and Marine 1991) Of note, Chinook salmon were observed passing DPD through February 2008. This migratory timing is consistent with known periods of immigration for adult late fall-run Chinook salmon. Late fall-run Chinook salmon, although specific to the Sacramento River, have been known to spawn in other Sacramento River tributaries including the Feather and Yuba rivers (USFWS 1995). Their migration period has been documented to occur from October through April, and peaks in December (Moyle 2002).

The length-frequency distributions for all Chinook salmon measured by the Vaki Riverwatcher systems fell within known age distributions obtained from the CDFG Chinook Salmon Scale-Age Program results (CDFG, unpublished data). A total of 347 samples were collected during the 2007 escapement survey to obtain estimates of age structure for Yuba River Chinook salmon. Distributions for age-3 Chinook overlapped length distributions for age-2, age-4 and age-5 fish. The 2007 age structure for Chinook salmon as identified by the Scale-Age Program was: 3.2% for age-2 (n=11); 45.2% for age-3 (n=157); 49.9% for age-4 (n=173); and 1.7% for age-5 (n=6). Data from this sample indicated that length distributions for Chinook salmon age classes were: age-2 (46-68 cm), age-3 (56-104 cm), age-4 (74-114 cm) and age-5 (86-105 cm) (Figure 3).

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[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/

Observations from the 2007 escapement survey identified that 3.1% of the total fresh carcasses observed were age-2 grilse (Massa 2008). This observation followed closely the results from scale-aging data from that year which identified 3.2% of the 2007 escapement to be comprised of grilse. In contrast, Vaki Riverwatcher observations using a 65 cm cutoff identified that 7.1% of fish were age-2. Using the scale-age program cutoff of 68 cm, 9.5% were identified as age-2 grilse. Explanations for this observed discrepancy are tenuous, but could likely be described by either of the following two scenarios; 1) escapement survey observations are suspected to under represent age-2 Chinook salmon due to their size relative to larger carcasses;, and/or 2) length measurements from the Vaki systems are estimated from a body depth measurement and are not an actual measure of length. The Vaki systems utilize a user-defined ratio to estimate length based upon a known body depth as measured anterior to the dorsal fin. Since the Vaki length/depth ratio is an average of morphometric measurements and represents an amalgam of different age classes and sexually dimorphic characteristics, the system likely overestimates the length of small fish and underestimates the length of large fish.

A generalized logistic function was used to describe the cumulative distribution of net upstream passage (Figure 5) and the cumulative fraction of steelhead trout above DPD (Figure 6); however, a singular generalized logistic function could not describe the cumulative distribution of net upstream passage of Chinook salmon above DPD (Figure 7). Multiple asymptotes in passage were observed that required a stratification of the survey period (Figure 8). An analysis of modal distributions compiled from previous Vaki system data (2004-2007) supported this observation (Figure 9).

Chinook salmon and steelhead trout were not observed to express any discernable pattern between daily net passage and water temperature (Figure 10 and Figure 11) and no pattern was observed between daily net steelhead trout passage and flow (Figure 12). However, a small modal peak of Chinook salmon passage was observed between the last week of August 2007 and the first week of September 2007 (Figure 13) that coincided with annual fall flow reductions. Lower Yuba River flows at the USGS Smartsville gage were reduced by approximately 300 cfs from August 31, 2007 to September 1, 2007 to achieve fall target levels. In the weeks preceding this flow reduction (August 1, 2007 to August 30, 2007), relatively few Chinook salmon were observed to pass DPD by the Vaki systems (n=25). On August 31, 2001, 28 Chinook salmon ascended DPD during a 24-hour period that appeared to be temporally aligned with this fall target flow reduction.

Peak passage observations of steelhead trout at DPD occurred from April 2007 through June 2007. This observation contrasts results from other studies in the Central Valley which indicate that adult steelhead trout immigrate into Central Valley rivers from August through March (McEwan 2001; NMFS 2004), and peak during January and February (Moyle 2002). Baseline data for steelhead trout gathered from trapping studies conducted by Hallock in the Sacramento River above the Feather River confluence described migratory periods occurring from July through March, with peak occurrence during mid- to late-September (1989). Trapping at Red Bluff Diversion Dam from 1969-1982 also identified migration patterns that were dissimilar to lower Yuba River observations at DPD; adult immigration began in July and extended into May (Hallock 1989). Data from the Feather River observed adult steelhead trout immigration from

November to April with peak occurrence from November through January (McEwan and Jackson 1996).

Two recent reports (Zimmerman et al. 2008, Mitchell 2010) concluded that the lower Yuba population of steelhead trout contains a relatively low proportion of anadromous individuals. Zimmerman et al. (2008) used otolith microchemistry to evaluate the maternal origin of juvenile steelhead trout from the Central Valley. Of 141 fish collected from the Yuba River between 2001 and 2007, 13% were of anadromous origin. Mitchell (2010) used scale analysis to investigate the life history characteristics of steelhead trout in the lower Yuba River; he determined from a limited sample of migrating adults from ladder trapping at Daguerre Point Dam that 14% of these fish were anadromous, whereas 1% of the fish captured by angling methods were identified as anadromous. The relative proportion of resident steelhead trout occurring in the Yuba River may explain the apparent misalignment with known immigration periods, since the Vaki systems did observe larger steelhead trout (> 40.6 cm) passing DPD during the winter months (December through February). This observation is similar to known Feather River migrations from McEwan and Jackson (1996) and from adult counts at Clough Dam on Mill Creek for a 10-year period beginning in 1953 that indicated the adult steelhead trout peak migration occurred in late-October, with a smaller peak in mid-February (McEwan 2001). Additionally, the relatively high fraction of resident steelhead trout documented in the Yuba River by Zimmerman et al. (2008) and Mitchell (2010) do not reflect observations recorded prior to the construction of New Bullard's Bar Dam in 1969. For example, length-frequency data from steelhead collected in the lower Yuba River from 1968-1970 (Wooster and Wickwire 1970), observed a mean length for steelhead of 56 cm, whereas fish collected after completion of New Bullards in 1976-1977 (CDFG unpublished data) a mean length of 63 cm (excluding fish < 35.6 cm), possibly indicating an observed shift in expressed phenotypic life history traits. Since system failures caused by LVD were prevalent during these winter migration periods, a relative uncertainty exists that the temporally-fragmented picture of lower Yuba River steelhead trout passage provided by the Vaki Riverwatcher systems accurately explains actual migratory patterns.

Future analysis of Vaki Riverwatcher observations will include efforts to fill data gaps caused by system malfunctions. Possible methods include linear interpolation when appropriate, but more sophisticated methods (e.g. fitting a polynomial or spline model) will likely be necessary to address observations that omit or possibly represent a truncation of asymptotic peaks.

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Table 1. Vaki Riverwatcher system operation.

| | Days of Operation | Days Possible | % Operation |
|---|---|---|---|
| Mar-07 | 29.0 | 31 | 93.5 |
| Apr-07 | 29.3 | 30 | 97.2 |
| May-07 | 28.5 | 31 | 91.9 |
| Jun-07 | 23.3 | 30 | 77.1 |
| Jul-07 | 26.7 | 31 | 86.1 |
| Aug-07 | 27.3 | 31 | 87.9 |
| Sep-07 | 26.3 | 30 | 87.2 |
| Oct-07 | 30.9 | 31 | 99.6 |
| Nov-07 | 29.8 | 30 | 98.8 |
| Dec-07 | 26.8 | 31 | 86.3 |
| Jan-08 | 12.4 | 31 | 40.1 |
| Feb-08 | 26.1 | 29 | 90.1 |

Table 2. Net passage and percentage of total passage for Chinook salmon (adipose fin present, adipose fin clipped, adipose fin undetermined and total), steelhead trout, Sacramento sucker, Sacramento pikeminnow, hard head, and unidentified fish species recorded by the Vaki Riverwatcher at Daguerre Point Dam; and percent passage at the North ladder for each species.

| | Chinook Salmon | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Adipose present | Adipose clipped | Un-determined | Total | Steelhead trout | Sacramento sucker | Sacramento pikeminnow | Hardhead | Unidentified | Total |
| Mar-07 | 4 | 3 | 1 | 8 | 61 | 255 | 43 | 1 | 150 | 518 |
| Apr-07 | 2 | 0 | 0 | 2 | 164 | 217 | 72 | 22 | 213 | 690 |
| May-07 | 131 | 20 | 2 | 153 | 106 | 33 | 47 | 19 | 278 | 636 |
| Jun-07 | 67 | 12 | 0 | 79 | 182 | 38 | 15 | 4 | 214 | 532 |
| Jul-07 | 40 | 2 | 0 | 42 | 18 | 12 | 1 | 0 | 37 | 110 |
| Aug-07 | 52 | 0 | 1 | 53 | 30 | 7 | 2 | 0 | 18 | 110 |
| Sep-07 | 51 | 1 | 0 | 52 | 3 | 0 | 0 | 0 | 1 | 56 |
| Oct-07 | 316 | 6 | 8 | 330 | 11 | 0 | 1 | 0 | 5 | 347 |
| Nov-07 | 362 | 2 | 10 | 374 | 14 | 0 | 0 | 0 | 22 | 410 |
| Dec-07 | 169 | 4 | 13 | 186 | 33 | 3 | 0 | 0 | 35 | 257 |
| Jan-08 | 19 | 9 | 6 | 34 | 11 | 3 | 1 | 0 | 30 | 79 |
| Feb-08 | 6 | 4 | 1 | 11 | 65 | 89 | 7 | 0 | 193 | 365 |
| Total # | 1219 | 63 | 42 | 1324 | 698 | 657 | 189 | 46 | 1196 | 4110 |
| % of total | | | | 32.21% | 16.98% | 15.99% | 4.60% | 1.12% | 29.10% | 100.00% |
| % North Ladder | | | | 84.74% | 51.72% | 80.82% | 94.18% | 93.48% | 60.28% | 75.05% |

Table 3. Descriptive statistics of length (cm) of all Chinook salmon (adipose fin present, adipose fin clipped, and adipose fin undetermined), and steelhead trout for net passage upstream of Daguerre Point Dam in the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

| | **Chinook Salmon** | | | **Steelhead trout** |
|---|---|---|---|---|
| | Adipose present | Adipose clipped | All | |
| Mean | 83 | 76 | 82 | 27 |
| Median | 84 | 78 | 83 | 23 |
| Mode | 79 | 74 | 79 | 18 |
| Minimum | 20 | 43 | 20 | 18 |
| Maximum | 111 | 100 | 111 | 76 |
| 95% CI for Mean | 0.74 | 2.83 | 0.75 | 0.77 |
| Standard Deviation | 13.10 | 11.24 | 13.86 | 10.38 |
| Coefficent of Variation | 0.16 | 0.15 | 0.17 | 0.39 |

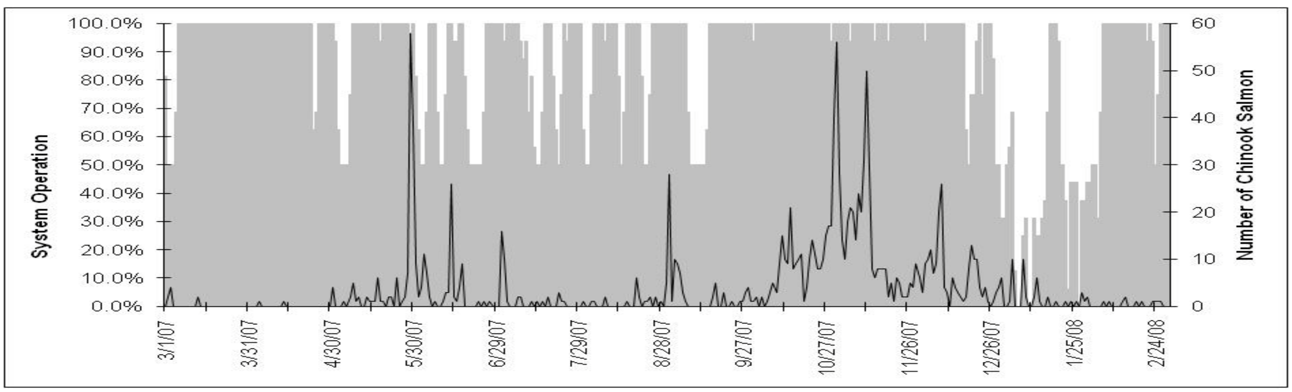


Figure 1. Daily net upstream passage of Chinook salmon above Daguerre Point Dam in the lower Yuba River (black line), CA and percentage of time the Vaki Riverwatcher systems were inoperable (gray shading) from March 1, 2007 through February 29, 2008.

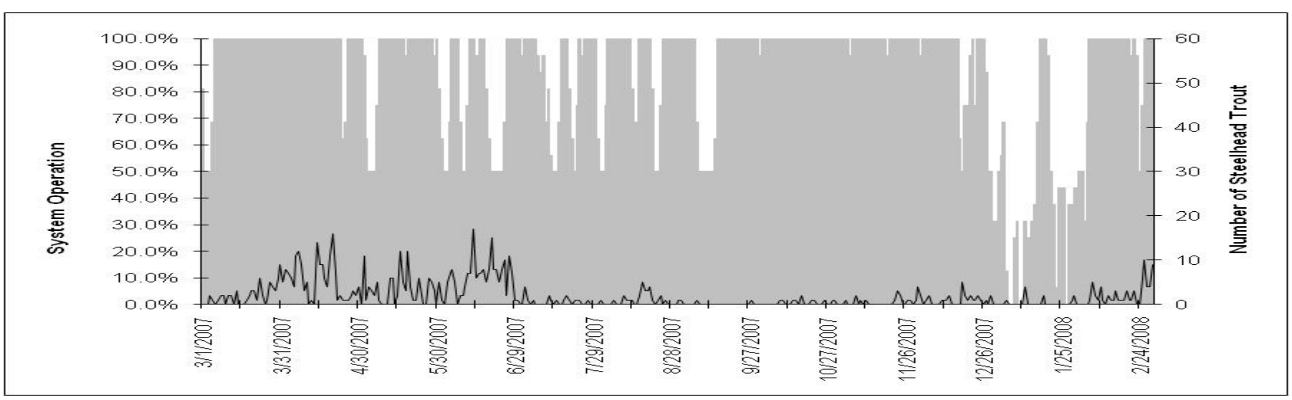


Figure 2. Daily net upstream passage of steelhead trout above Daguerre Point Dam in the lower Yuba River (black line), CA and percentage of time the Vaki Riverwatcher systems were inoperable (gray shading) from March 1, 2007 through February 29, 2008.

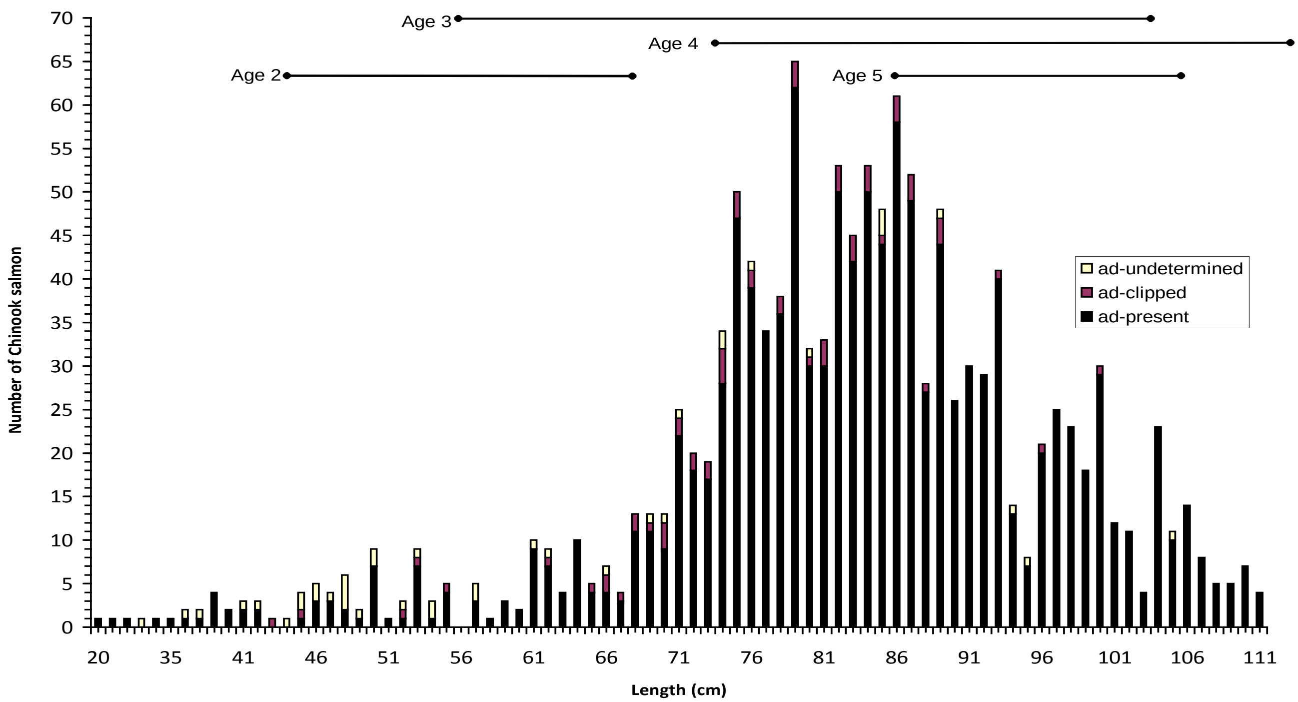


Figure 3. Length (cm) frequency of all Chinook salmon (adipose fin present, adipose fin clipped, or adipose fin undetermined) above Daguerre Point Dam in the lower Yuba River, CA with age classes identified from Grover, et.al. (2008) from March 1, 2007 through February 29, 2008.

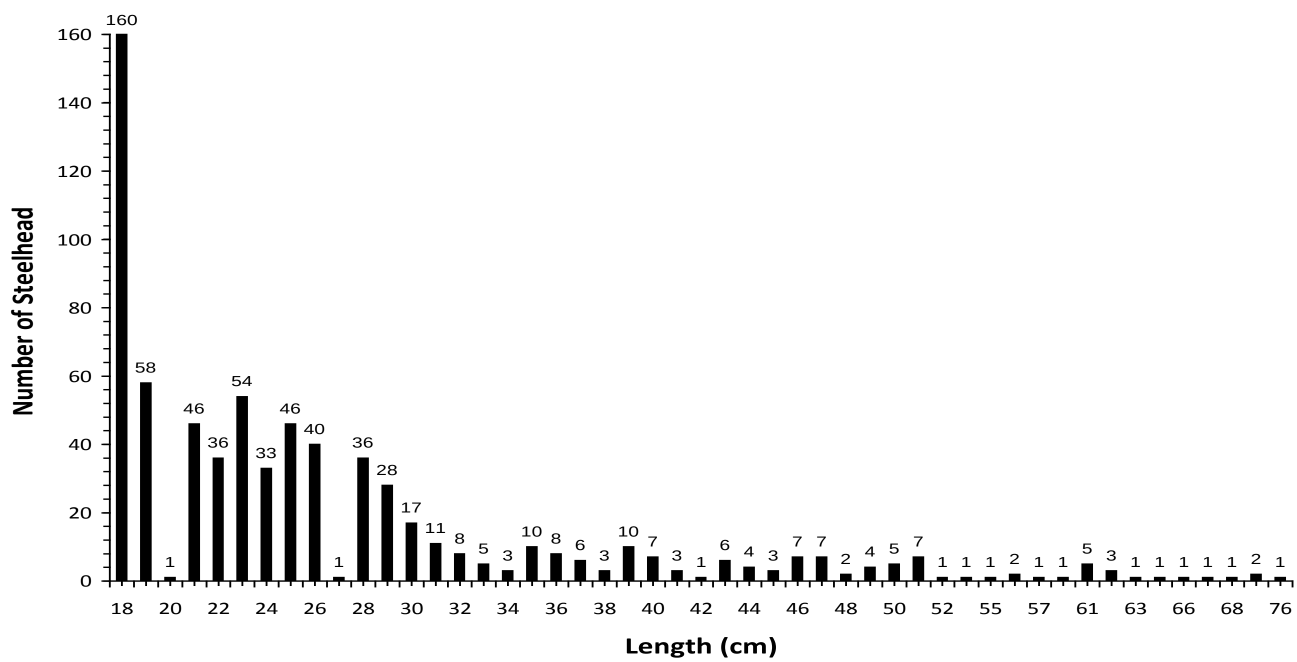


Figure 4. Length (cm) frequency histogram of the net passage of steelhead trout above Daguerre Point Dam in the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

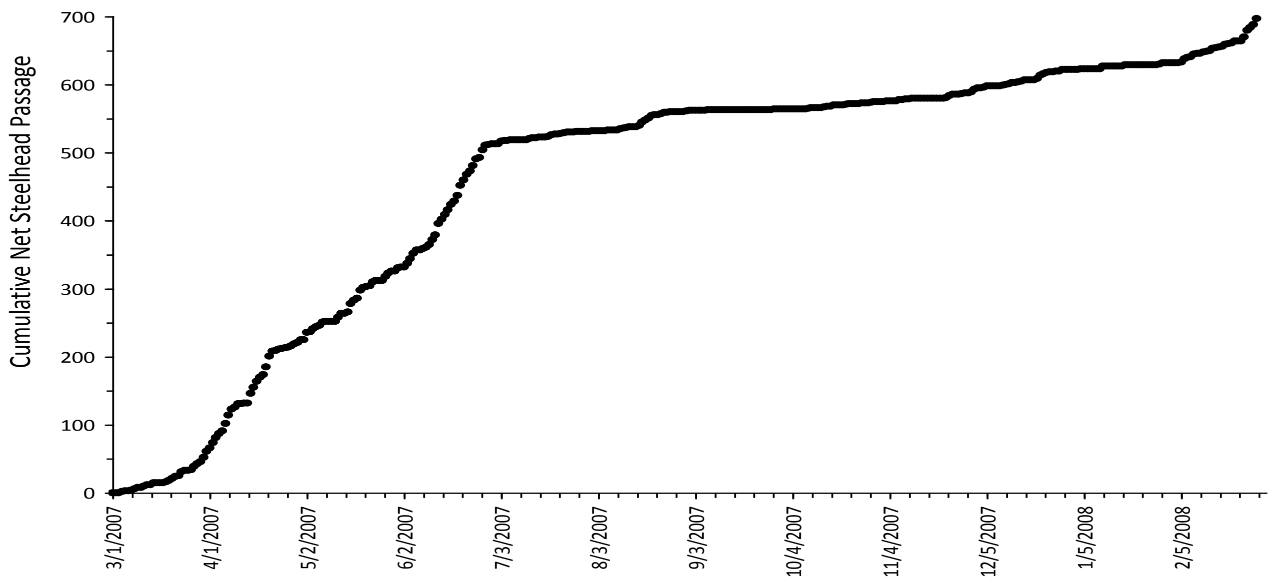


Figure 5. Cumulative net upstream passage of steelhead trout at Daguerre Point Dam in the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

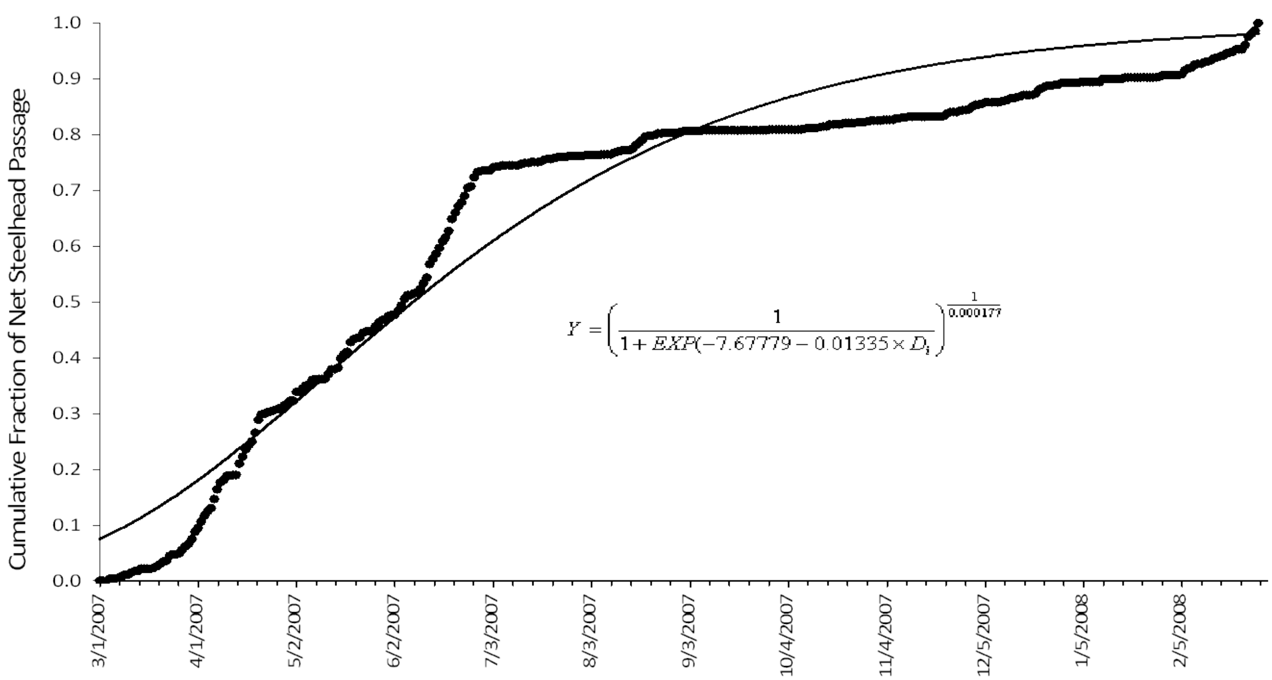


Figure 6. Cumulative fraction of net upstream passage of steelhead trout at Daguerre Point Dam in the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

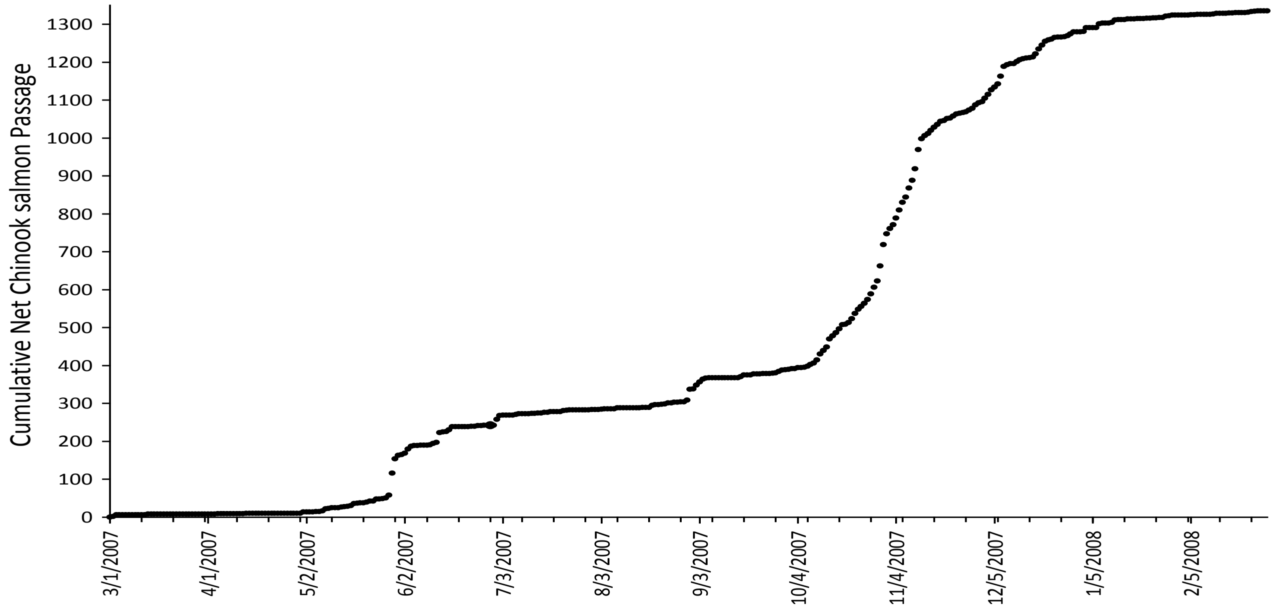


Figure 7. Cumulative net passage of Chinook salmon at Daguerre Point Dam in the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

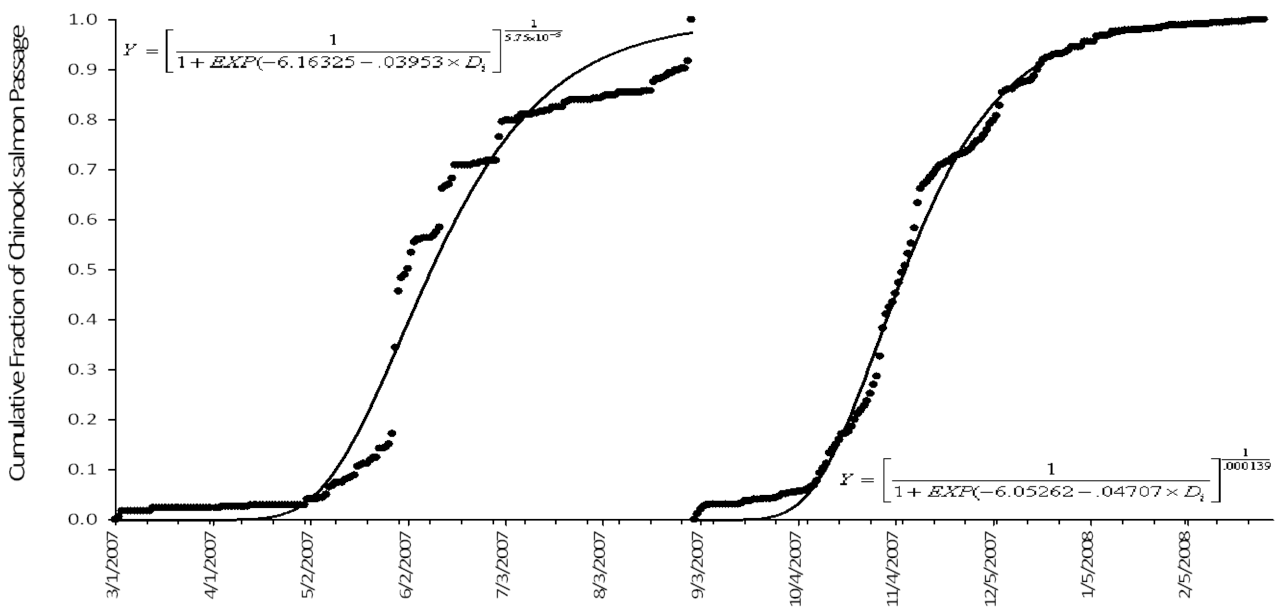


Figure 8. Cumulative fraction of net upstream passage of Chinook salmon at Daguerre Point Dam on the lower Yuba River, CA with the cumulative distribution functions describing net upstream passage from 3/1/2007-8/31/2007 and 9/1/2007-2/29/2008.

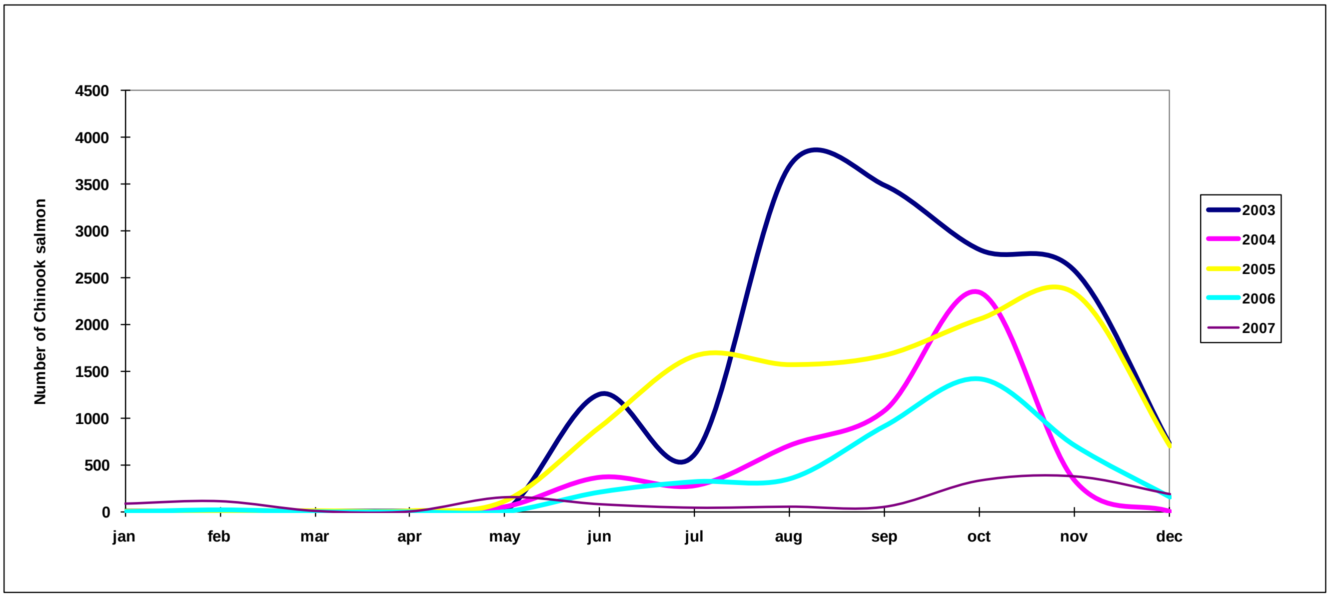


Figure 9. Daily net upstream passage of Chinook salmon at Daguerre Point Dam in the lower Yuba River, CA from June 20, 2003 through December 31, 2007 (CDFG, unpublished data).

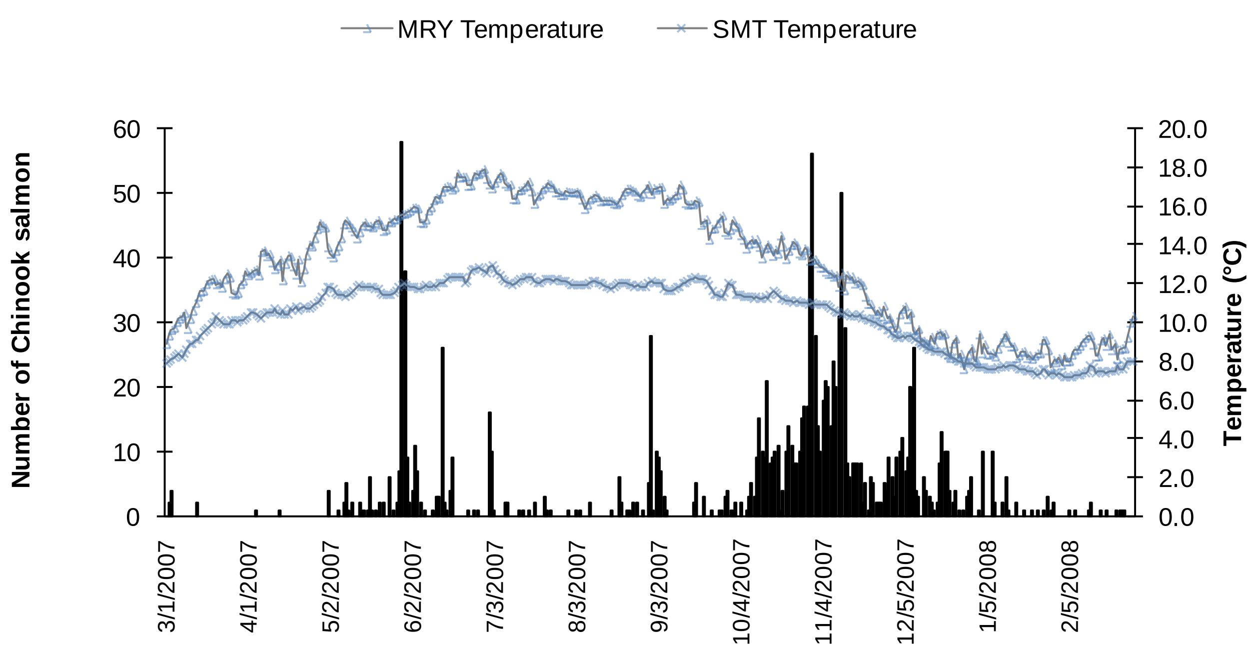


Figure 10. Daily net passage of Chinook salmon at Daguerre Point Dam and water temperature at the Smartsville and Marysville gage (CDEC station "MRY"; USGS 11424000 and CDEC station "YRS") on the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

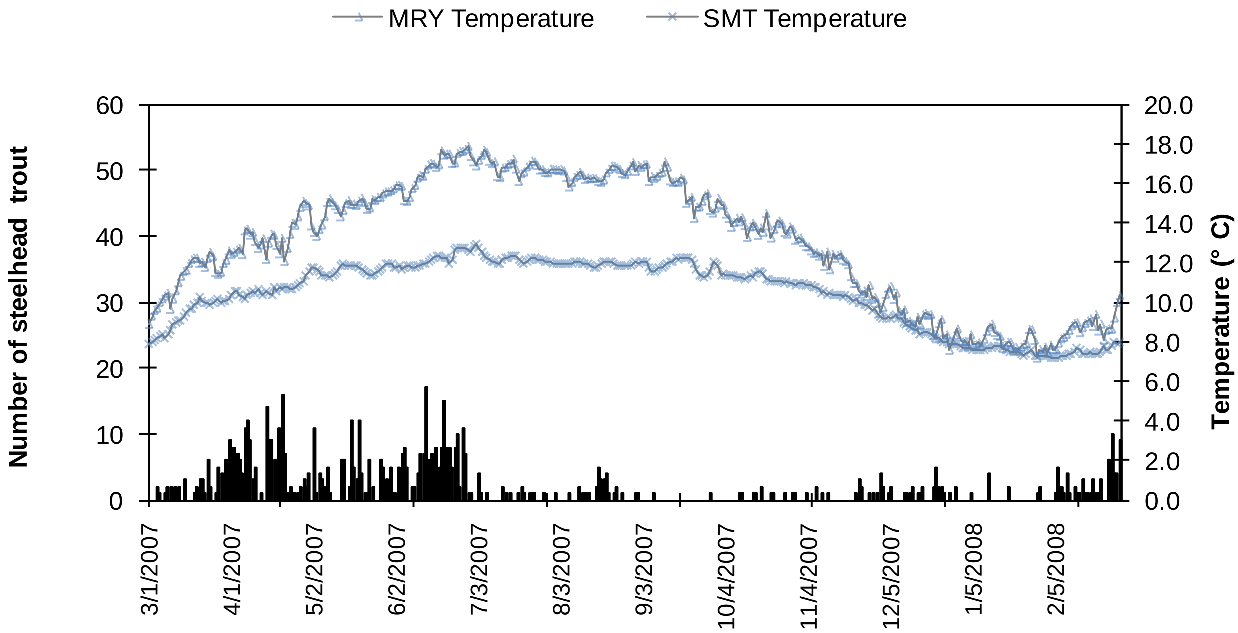


Figure 11. Daily net passage of steelhead trout at Daguerre Point Dam and water temperature at the Smartsville and Marysville gage (CDEC station "MRY"; USGS 11421000 and CDEC station "YRS") on the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

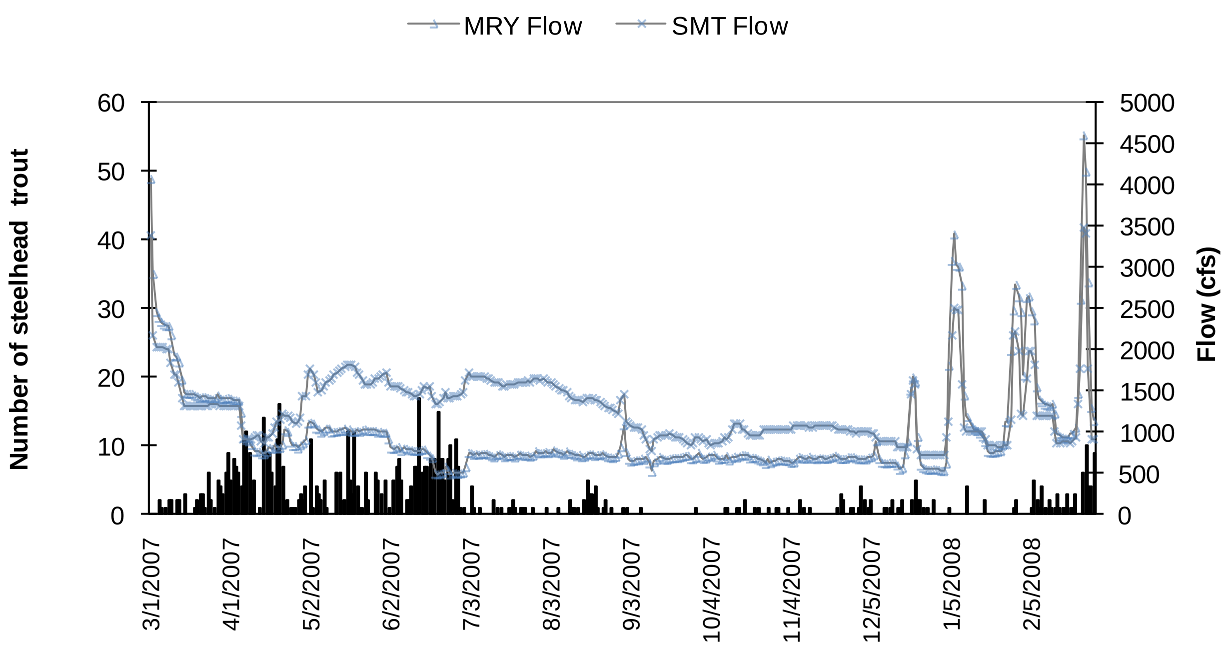


Figure 12. Daily net passage of steelhead trout at Daguerre Point Dam and stream flow (cfs) at the Smartsville and Marysville gage (CDEC station "MRY"; USGS 11421000 and CDEC station "YRS") on the lower Yuba River, CA from March 1, 2007 through February 29, 2008.

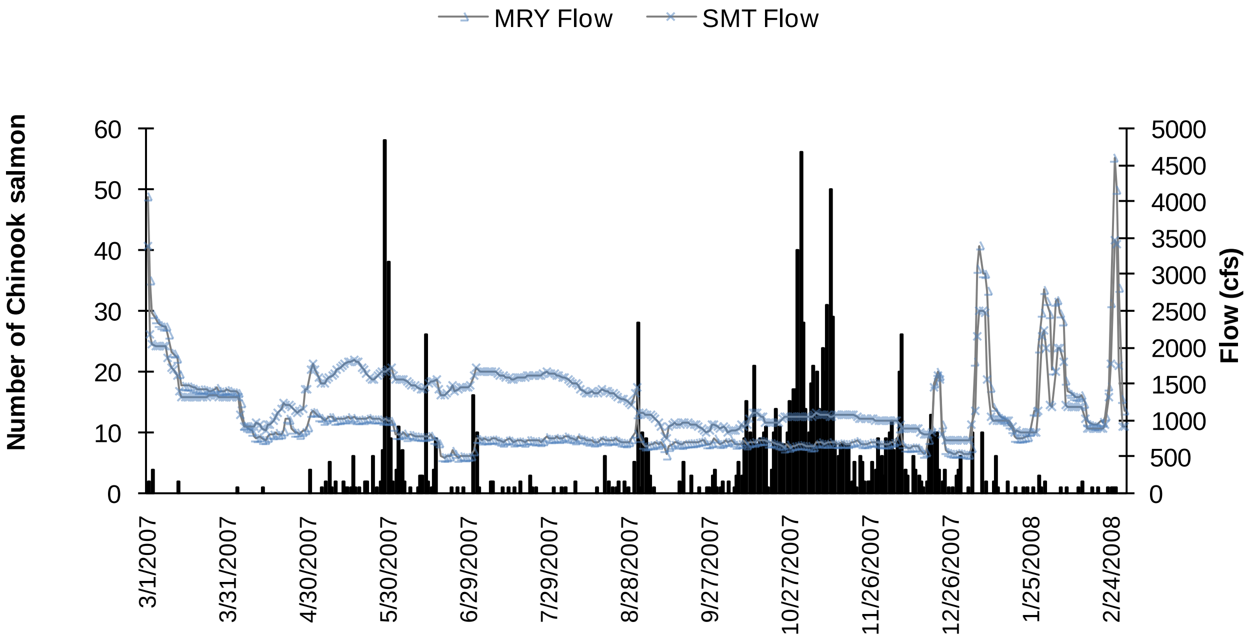


Figure 13. Daily net passage of Chinook salmon at Daguerre Point Dam and stream flow (cfs) at the Smartsville and Marysville gage (CDEC station “MRY”; USGS 11421000 and CDEC station “YRS”) on the lower Yuba River, CA from March 1, 2007 through February 29, 2008.