LOWER YUBA RIVER ACCORD MONITORING AND EVALUATION PLAN

ANNUAL ESCAPEMENT SURVEY REPORT

SEPTEMBER 24, 2008 – DECEMBER 23, 2008

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by
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INTRODUCTION

The lower Yuba River 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 (http://www.yubaaccordrmt.com/Yuba%20Accord%20Documents/Forms/AllItems.aspx).

The RMT Planning Group includes representatives of the Yuba County Water Agency, National Marine Fisheries Service, U.S. Fish and Wildlife Service, California Department of Fish and Game (CDFG), Pacific Gas and Electric and one representative for the four non-governmental organizations 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.

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 used for population estimation (i.e. Peterson, Jolly-Seber, Schaefer) were not consistent between years. Additionally, the lower Yuba river from the Narrows Pool downstream to the HWY 20 Bridge (also referred to as the Blue

Point Mine Reach and the Rose Bar Reach) was not surveyed from 1973-1993[1] (Nelson 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 (HWY 20-mouth) to produce escapement estimates above HWY 20 from 1973-1993[2] (Nelson 1995).

Recent surveys (1994, 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 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.

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 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 the temporal distribution of abiotic factors (i.e., 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

[1] 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).

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

- 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.

Field Methods

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

Deviations from the Escapement Survey Protocols and Procedures

Genetic tissue and otolith sampling did not commence this year, as the associated sampling protocols for these surveys were added *post facto* to the Escapement Survey Protocols and Procedures. Future escapement surveys conducted from 2009 through 2013 and will collect genetic tissue samples and otoliths from all fresh carcasses. Genetic analyses will be used to identify the genetic composition of Chinook salmon in the lower Yuba River, as well as identify any genetic differences between those fish expressing spring- and fall-run phenotypic behavior. Otolith microchemical and structural analysis will be used to identify the natal origin of lower Yuba River Chinook salmon (i.e., hatchery origin, natural origin and river of origin) and potentially to identify periods freshwater and ocean residency as well as adult and juvenile growth patterns. Water turbidity measurements as reported in this annual report were collected at the rotary screw trap (RST) site near Hallwood Boulevard.

Two U.S. Geological Survey (USGS) gaging stations were to be used to monitor mean daily flow on the lower Yuba River during the escapement survey. The USGS Smartsville gage is located just downstream of Englebright Dam. Data for this gage are not available at this time. For this report, mean daily flow data from the California Data Exchange Center (CDEC) were substituted for the reporting period.

Data Analysis Methods

Escapement Survey Process

The number of carcasses observed during the 2008 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 the adult and grilse carcasses recaptured.

Coded-wire tags (CWT) recovered during the 2008 escapement survey were reported in tabular format with the following data: recovery date, CWT number, brood year, race, hatchery-origin, release date, release location, sex, and fork length.

To describe the temporal distribution of fresh carcasses observed during the 2008 escapement survey a cumulative distribution plot was developed. A standard seven-day week was utilized as the independent variable and the cumulative fraction of the weekly-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 2008 escapement survey (i.e., Reach 1, Reach 2, Reach 3, the entire survey area, above Daguerre Point Dam (DPD), and below DPD).

Abiotic variables (i.e., mean daily flow, water temperature, and turbidity) for the survey period (9/24/2008-12/23/2008) were compared with the temporal distribution of observed fresh carcasses.

Abundance

A modified-Schaefer model (1951) was used to estimate adult Chinook salmon abundance using the adult carcass mark-recapture 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 a modified-Schaefer model due to the relatively low occurrence of grilse carcass observations during weekly surveys. A grilse estimate was instead obtained by expanding the adult Schaefer abundance estimate using a proportional multiplier derived from the observed ratio of fresh adult to grilse carcasses recorded during the survey period. The resultant grilse abundance estimate was then summed to the adult Schaefer abundance estimate to create a total abundance estimate for Chinook salmon on the lower Yuba River.

Abundance estimates and analyses associated with hatchery origin and natural origin Chinook salmon were not possible because; 1) otoliths were not collected during the 2008 escapement survey to identify origin (i.e., hatchery and/or natal river origin);, and 2) the California Department of Fish and Game (CDFG) Constant Fractional Marking Program's first age-3 returns (adults) will not be observed in the lower Yuba River until the fall of 2009.

To differentiate spring- and fall-run Chinook salmon, temporal modalities associated with fresh carcass observations were examined (Figure 3) and compared with the frequency of redds observed during the 2008 pilot redd survey. Temporal modes were also compared with the cumulative distribution of observed carcasses and redds (Appendix A and B) and the occurrence frequency of Chinook salmon passing DPD as observed by the videographic monitoring systems (Vaki) (Appendix C). This examination did not provide a clear distinction between spring- and fall-run Chinook salmon. As a result, escapement data were not reported by run and all analyses were completed using all Chinook salmon data collected during the survey period.

Annual fluctuations (relative increase or decrease) in the run size of Chinook salmon in the lower Yuba River were compared to other Central Valley Rivers. The annual run sizes for other Central Valley Rivers

were obtained from GrandTab[3] for fall-run Chinook salmon in the following rivers: Sacramento River, Battle Creek, Deer 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.

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 length data from fresh carcasses measured during the 2008 escapement survey. Length frequencies were also examined to describe the annual size structure for each sex (male and female). Descriptive statistics were used to illustrate the 2008 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 2008 Chinook salmon population could not be examined at this time. Data from the CDFG Scale-Aging Program for this analysis was unavailable (Pers. Comm., Brett Kormos, CDFG, 2009).

Results

The 2008 escapement survey was conducted from September 24, 2008 to December 23, 2008. A summary of data collected during the escapement survey is described in Table 1.

During the 2008 escapement survey, field crews visually estimated the spawning status of all fresh females (spawned or unspawned). A total of 191 fresh female adult carcasses were visually inspected for spawning. No unspawned fresh females were encountered during the 2008 survey.

A total of six CWTs were recovered from carcasses on the lower Yuba River in 2008 (Table 2). Four of the six total CWT Chinook salmon recoveries originated from the Feather River Hatchery, whereas the remaining recoveries originated from the Coleman National Fish Hatchery. Feather River Hatchery spring-run Chinook salmon accounted for 50 percent of the recovered CWTs. The remaining CWT recoveries were identified as fall-run Chinook salmon from the Feather River Hatchery and Coleman National Hatchery. Natural origin CWT recoveries, from CDFG's lower Yuba River Life History Investigations (2003-2006), were not observed during the 2008 escapement survey. No additional carcasses with external marks (i.e., floy tags) were detected.

A cumulative distribution of fresh Chinook salmon carcasses observed from 9/24/2008 to 12/23/2008 was developed to examine the relative proportions of fresh carcasses observed during the season (Figure 1). By 10/15/2008, 39 percent of all fresh carcasses were observed and 79 percent of all fresh carcasses were observed by 10/29/2008. Nearly 100 percent of fresh carcasses for the 2008 escapement survey were observed by 12/10/2008.

The majority of fresh Chinook salmon carcasses were observed from the Narrows Pool to DPD (Figure 2). Fresh Chinook salmon carcasses from the Narrows Pool to HWY 20 (Reach 1) were observed from

[3] 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

10/01/2008 through 12/03/2008. Peak carcass observations for Reach 1 occurred on 10/15/2008 and 10/22/2008 (Figure 2). Fresh Chinook salmon carcasses were observed from HWY 20 to DPD (Reach 2) from 9/24/2008 through 12/03/08. Fresh Chinook salmon carcasses were observed from DPD to Simpson Lane Bridge (Reach 3) from 10/15/2008 through 12/17/2008. The total number of fresh carcasses observed per week in Reach 3 ranged from one to five. Peak observations of fresh Chinook salmon carcasses were recorded for all reaches in the lower Yuba River during a two-week period beginning 10/14/2008 (Figure 3).

The majority of fresh Chinook salmon carcasses were observed above DPD (Figure 4). For the 2008 escapement survey, 93 percent of fresh carcasses were observed above DPD and 7 percent were observed below. Of the total number of fresh carcasses observed, 51 percent were above the HWY 20 Bridge.

The mean daily flows during the escapement survey measured at Smartsville ranged from 799 cfs to 915 cfs with a mean of 852 cfs (Figure 5). Mean daily flows at the Marysville gage ranged from 505 cfs to 691 cfs with a mean of 561 cfs (Figure 6).

The daily water turbidity at the RST site ranged from 0.64 NTU to 4.5 NTU, with a mean daily value for the entire survey period (9/24/2008-12/23/2008) of 1.47 NTU.

The mean daily water temperatures at the RST site ranged from 8.6 °C to 16.7 °C, with a mean daily water temperature for the entire survey period (9/24/2008-12/23/2008) of 13.2 °C (Figure 8).

Abundance

To differentiate spring- and fall-run Chinook salmon carcasses, the temporal distributions of observed Chinook salmon carcasses illustrated in Figure 3 were examined in conjunction with data observations collected during the 2008 pilot redd survey (Figures 14 and 15), and with observations collected from the Vaki systems at DPD (Figure 16). No clear temporal distinction could be made between spring- and fall-run Chinook salmon carcasses, as the singular temporal mode associated with carcass observations could not be correlated to any relationship between the bi- and tri-modal distributions associated with the 2008 pilot redd survey and Vaki system observations.

The adult Chinook salmon abundance estimate from the modified-Schaefer model was 3,084 (Table 3). The grilse abundance estimate was calculated using an observed adult to grilse ratio of 7.28:1, resulting in a grilse abundance estimate of 424 (Table 3). The total abundance of Chinook salmon (adult and grilse) returning to the lower Yuba River was estimated to be 3,508 (Table 3). Harvest by recreational fisheries in the lower Yuba River was not incorporated into the abundance estimate because none occurred due to statewide ocean and inland fisheries closures in 2008.

The lower Yuba River was one of six rivers in the California Central Valley where the abundance of Chinook salmon increased from the 2007 abundance estimate (Table 4). The 2008 abundance estimate for Chinook salmon increased by 904 salmon from the 2007 estimate. This represents an increase of approximately 35 percent from the previous year.

Diversity

The size of all fresh Chinook salmon sampled (n = 380) ranged from 470 mm to 1200 mm, and the average size was 798 ± 12.61 mm (Table 5 and Figure 9). The most frequently observed total length for Chinook salmon was 770 mm (Table 5 and Figure 9). The median length for all Chinook salmon was 798 mm (Table 5).

No female Chinook salmon observed had an adipose fin-clip (n = 191), and their size ranged from 515 mm to 980mm, with an average size of 776 ± 11.06 mm (Table 5 and Figure 10). The most frequently observed total length for female Chinook salmon was 790 mm (Table 5 and Figure 10). The median length for female Chinook salmon was 780 mm (Table 5).

Fresh male Chinook salmon carcasses sampled (n = 189) ranged in size from 470 mm to 1200 mm, with an average size of 819 ± 22.47 mm (Table 5 and Figure 11). The most frequently observed total length for male Chinook salmon was 890 mm (Table 5 and Figure 11). The median length of male Chinook salmon was 870 mm (Table 6).

Male Chinook salmon that were adipose fin-clipped (n = 6) ranged in size from 540 mm to 1200 mm, with an average size of 838 ± 262.27 mm (Table 5 and Figure 12). No mode for total length was observed for male adipose fin-clipped Chinook salmon (Table 5 and Figure 12) in 2008. The median length was 830 mm (Table 5).

Male Chinook salmon that were non-adipose fin-clipped (n = 183) ranged in size from 470 mm to 1110 mm, with an average size of 819 ± 22.41 mm (Table 5 and Figure 13). The most frequently observed total length for male non-adipose fin-clipped Chinook salmon was 890 mm (Table 5 and Figure 13). The median length was 870 mm.

Discussion & Recommendations

- Modalities associated with the temporal distribution of observed fresh carcasses from the 2008 escapement survey could not clearly distinguish spring- and fall-run Chinook salmon carcasses. Other distributional elements (date of observation, frequency, magnitude) collected from pilot redd survey observations and Vaki passage occurrences do suggest some temporal and spatial separation, but the singular temporal mode associated with carcass observations could not be correlated to any relationship between modal distributions associated with the 2008 pilot redd survey or Vaki system observations. The frequency distribution of immigrating Chinook salmon passing DPD suggests a more distinguishable separation of runs; however, this observation does not help to positively identify the relative run size for spring- and fall-run Chinook salmon through Schaefer mark-recapture methods. The escapement survey observations likely reflect components of both spring- and fall-run Chinook salmon as a result of spatial-temporal overlap as well as post-mortem carcass drift within the system prior to field observation. Moyle (2002) also found that the spawning period for spring- and fall-run Chinook salmon in the California Central Valley overlapped considerably. Tissue samples will be collected during future escapement surveys to potentially differentiate spring- and fall-run Chinook salmon using genetic analyses. These analyses should allow us to address the analytics associated with run differentiation described in the M&E Plan.
- Abundance estimates for hatchery origin and natural origin Chinook salmon could not be calculated because; 1) first Age 3 returns (2006 brood-year) from the CDFG constant-fractional marking program will not be observed until fall 2009;, and 2) otoliths were not collected during

the 2008 escapement survey that could be used for microchemical and structural analysis to definitively determine origin (i.e., out-of-basin, hatchery, or natural origin) and fresh water/ocean residency. For the 2009 escapement survey, otoliths will be collected from all fresh carcasses.

- The majority of fresh Chinook salmon carcasses were observed above DPD (survey Reach 1 and 2) compared to below DPD (survey Reach 3) during the 2008 escapement survey. 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; Jones and Stokes 2006). During the 2007 escapement surveys 70% of the carcasses were observed above DPD (Massa 2008).

  This observation has significant implication in supporting future restoration actions on the Yuba River for spawning and rearing areas located above HWY 20 and DPD; and specifically for the proposed site rehabilitation at Sinoro Bar[4]. Areas upstream of the Narrows Pool have been identified having unsuitable spawning substrates for Chinook salmon. Additionally, the natural geomorphic processes essential to providing high quality spawning habitats have been impaired through the construction of Englebright Dam. Furthermore, the quantity and quality of salmonid spawning habitat in this reach has been significantly reduced by the deposition of large, consolidated rock fragments (i.e. "shotrock") downstream of Englebright Dam. 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.

- All fresh female carcasses encountered were visually characterized as spawned. This observation is inconsistent with previous pilot studies involving dissimilar procedures. An egg retention study conducted in 2005 inspected every tenth fresh female carcass encountered during weekly escapement surveys by opening the abdominal cavity. The study identified that 15 percent of the fresh female carcasses observed were either partially spawned or completely unspawned (approximately 4 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

[4] 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.

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.

Observations resulting from differing survey methods are often difficult to characterize and to compare. For future egg retention studies, an approach using consistent methods is suggested.

- The 2008 escapement survey had a much larger grilse component than what was observed in the previous 2006 and 2007 escapement surveys (Massa 2007, 2008). The adult to grilse ratio for the 2008 survey was 7.28:1 (3,087:424). This is much lower than the 2007 adult to grilse ratio of 29.9:1 (2,423:81) and 2006 adult to grilse ratio of 34.3:1 (7998:233). 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-3 fish for the following year (Pers. Comm. J. Duran, CDFG).

- For the 2009-2016 escapement surveys, water transparency using a secchi disk will be collected in lieu of turbidity measurements. 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 were not accounted for, and thus the ability of an observer to see a submerged carcass was not accurately represented by previous methods.

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Table 1. Survey period, date, survey reach, the number of female or male adult and grilse carcasses tagged, the number of adult and grilse Chinook salmon carcasses chopped or recaptured, and total numbers of carcasses captured for the mark-recapture escapement survey on the lower Yuba River, CA, 9/24/2008-12/23/2008.

Survey Period	Date	Survey Reach	Adults Tagged		Grilse Tagged		Chops*		Recaptures	
			Females	Males	Females	Males	Adults	Grilse	Adults	Grilse
Week 1	9/24/2008	"Hwy 20 – DPD"		1						
Week 2	9/30/2008	"Narrows – Hwy 20"	2	3			6			
	10/1/2008	"Hwy 20 – DPD"		2			1, 1*			
Week 3	10/7 /2008	"Narrows – Hwy 20"	8	14	1	3	13, 1*	1	1	
	10/8 /2008	"Hwy 20 – DPD"	2	11			16		1	
Week 4	10/14/2008	"Narrows – Hwy 20"	31	17	1	4	48, 1*	1	3	2
	10/15/2008	"Hwy 20 – DPD"	13	21	2	10	36	4		
	10/16/2008	"DPD – Simpson Ln."		1			3			
Week 5	10/21/2008	"Narrows – Hwy 20"	32	14	1	4	87, 1*		12	1
	10/22/2008	"Hwy 20 – DPD"	21	22	2	3	69	3,1*	9	1
	10/23/2008	"DPD – Simpson Ln."		3			6	3		
Week 6	10/28/2008	"Narrows – Hwy 20"	18	7			108	1	19	2
	10/29/2008	"Hwy 20 – DPD"	10	7		3	60, 1*	7	19	
	10/30/2008	"DPD – Simpson Ln."	1	1			6	1	1	
Week 7	11/4 /2008	"Narrows – Hwy 20"	5	2	1		32	4	16	
	11/5 /2008	"Hwy 20 – DPD"	1	2	1	2	27	3	9	1
	11/6 /2008	"DPD – Simpson Ln."	1	1			9	3		
Week 8	11/11/2008	"Narrows – Hwy 20"	8	2		1	19	5	9	
	11/12/2008	"Hwy 20 – DPD"	4	4			12	2	4	
	11/13/2008	"DPD – Simpson Ln."		1		1	9	1		
Week 9	11/18/2008	"Narrows – Hwy 20"	5	1			19		4	
	11/19/2008	"Hwy 20 – DPD"	3	2		2	25	1	3	
	11/20/2008	"DPD – Simpson Ln."	2	2		1	14	1		
Week 10	11/24/2008	"Narrows – Hwy 20"	3	1			14		5	
	11/25/2008	"Hwy 20 – DPD"	1				8	1		
	11/26/2008	"DPD – Simpson Ln."	2	1		1	14		1	
Week 11	12/1 /2008	"Narrows – Hwy 20"	1							
	12/2 /2008	"Hwy 20 – DPD"	2	2		1	5		6	
	12/3 /2008	"DPD – Simpson Ln."	3	2						
Week 12	12/10/2008	"DPD – Simpson Ln."	2	1			9			
Week 13	12/17/2008	"DPD – Simpson Ln."	1				3			
Total			182	148	9	36	683	43	120	7

*Chops with an asterisk are coded-wire tag chops.

Table 2. Coded-wire tag (CWT) number and recovery date for adipose-fin clipped carcasses on the lower Yuba River, CA collected from 9/24/2008 - 12/23/2008, with associated information including brood year, run, hatchery origin, release date, release location, sex, total length, and head tag number.

CWT Number	Date Recovered	Brood Year	Run	Hatchery Origin	Release Date	Release Location	Sex	Total Length	Tag Number
062460	1-Oct-08	2005	Spring	Feather R Hatchery	20060510	Feather River	M	770	30000
062337	7-Oct-08	2006	Spring	Feather R Hatchery	20070503	Feather River	M	610	30001
062438	14-Oct-08	2004	Spring	Feather R Hatchery	20050526	Live Oak	M	1200	30002
0501040702	21-Oct-08	2005	Fall	Coleman CNFH	20060216	Clarksburg	M	890	30003
601090105	22-Oct-08	2006	Fall	Feather R Hatchery	20070206	Yolo Bypass	M	540	30004
0501040702	29-Oct-08	2005	Fall	Coleman CNFH	20060216	Clarksburg	M	1100	30005

Table 3. Modified-Schaefer matrix used to estimate adult Chinook salmon abundance in the lower Yuba River from 9/24/2008 - 12/23/2008, including adult to grilse ratio, percent of grilse, abundance of grilse and total abundance.

	T(i)			E(i)	R(i)											
SURVEY	NUMBER	NUMBER	RATIO	TOTAL	Sum of Rows											
PERIOD	TAGGED	CHOPPED	E(i) / R(i)	EXAMINED	RECOVERED	**RECAPTURES OF FISH MARKED IN SURVEY PERIOD**										
1	7	9	0	16	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2	35	32	42.5	85	2	2											
3	83	88	58	174	3	0	3										
4	92	163	13.142857	276	21	0	1	20									
5	43	176	6.6153846	258	39	3	1	8	27								
6	12	68	4.2	105	25	0	0	5	5	15							
7	19	40	5.5384615	72	13	0	1	1	3	4	4						
8	15	58	11.428571	80	7	0	0	0	2	1	1	3					
9	8	32	9	45	5	0	0	0	1	0	0	1	3				
10	10	22	6.3333333	38	6	0	0	0	0	1	0	1	0	4			
11	3	5	2.3333333	14	6	0	0	0	0	0	0	0	2	0	4		
12		9	0	9	0	0	0	0	0	0	0	0	0	0	0	0	
Totals	327	702		1172	127												
				C(i) Total	127												
				C(i) RECOVERED	Sum of Columns	5	6	34	38	21	5	5	5	4	4	0	0
					T(i) / C(i) Ratio	1.40	5.83	2.44	2.42	2.05	2.40	3.80	3.00	2.00	2.50	0.00	0.00

SCHAEFER ESTIMATE CALCULATIONS:	
Total Population from Matrix =	3404
# Tagged from period 2 to last =	-320
Adult SCHAEFER ESTIMATE IS:	**3,084**
Adult to Grilse Ratio	7.279069767
Precent of Grilse	12.07865169
Grilse Estimate	**424**
Total Abundance	**3,508**

Survey Period	**Matrix of Population Estimates**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	-	-	-	-	-	-	-	-	-	-	-	-
2	119	0	0	0	0	0	0	0	0	0	0	0
3	0	1015	0	0	0	0	0	0	0	0	0	0
4	0	77	642	0	0	0	0	0	0	0	0	0
5	28	39	129	432	0	0	0	0	0	0	0	0
6	0	0	51	51	129	0	0	0	0	0	0	0
7	0	32	14	40	45	53	0	0	0	0	0	0
8	0	0	0	55	23	27	130	0	0	0	0	0
9	0	0	0	22	0	0	34	81	0	0	0	0
10	0	0	0	0	13	0	24	0	51	0	0	0
11	0	0	0	0	0	0	0	14	0	23	0	0
12	0	0	0	0	0	0	0	0	0	0	9	0
Totals	147	1163	836	601	211	81	189	95	51	23	9	0

Table 4. Annual abundance estimates for fall-run Chinook salmon in California Central Valley anadromous waters from 1994-2008.

Year	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	58546	24,274	2,546				1,081	307		38,382	10,890	31,520		1,238	1,031	506	2,646
1995	63934	56,515	9,298						445	59,912	14237*	80,330		2,194	619	827	2,320
1996	84086	52,409	5,922						500	57,170	27,900	74,745		4,038	168	4,362	3,291
1997	119296	50,744	8,569				478	1,203	800	50,547	25,948	52,195		3,681	5,588	7,146	2,714
1998	6318	53,957	4,259				546	270	500		31,090	54,792	300	4,122	3,087	8,910	3,292
1999	161192	92,929	8,003								24,230	55,339		2,183	4,349	8,232	3,129
2000	96688	53,447	6,687							114,717	14,995	99,059		1,973	8,498	17,873	11,130
2001	75152	100,604	10,865						4,433	178,645	23,392	135,384		2,307	7,033	8,782	9,181
2002	65690	397,149	16,071				2,611		3,665	105,163	24,051	124,252		2,840	7,787	7,173	8,866
2003	89229	64,764	9,475				2,426		3,492	89,946	28,316	163,742		2,122	5,902	2,163	2,530
2004	43604	23,861	6,365				1,192	300	2,516	54,171	15,269	99,230		1,588	4,015	1,984	1,050
2005	57012	20,520	14,824				2,426	946	4,255	48,586	17,630	56,843		10,406	3,315	719	2,111
2006	55468	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	17061	9,904	4,129	1,250	2,044	140	796	508	1,225	21,862	2,604	9,985	53	470	443	224	495
2008	25197	4,290	7,677	200	200	20	166	194	275	8,208	3,508	2,742	0	140	1,305	455	566

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

Table 5. Length distributions and descriptive statistics for of all fresh Chinook salmon carcasses (female adipose fin-clipped, female non-adipose fin-clipped, male adipose fin-clipped, male non-adipose fin-clipped) observed during escapement surveys on the lower Yuba River from 9/24/2008 – 12/23/2008.

Statistic	All	Female	Male		
		Non-Adipose Fin-Clipped	All	Non-AdiposeFin-Clipped	AdiposeFin-Clipped
n	380	191	189	183	6
Mean	798	776	819	819	838
Mode	770	790	890	890	NA
Minimum	470	515	470	470	540
Maximum	1200	980	1200	1110	1200
Median	792.5	780	870	870	830
SE	6.41	5.61	11.39	11.36	102.03
STDEV	125.05	77.47	156.61	153.65	249.91
CV	0.16	0.10	0.19	0.19	0.30
95% CI	12.61	11.06	22.47	22.41	262.27

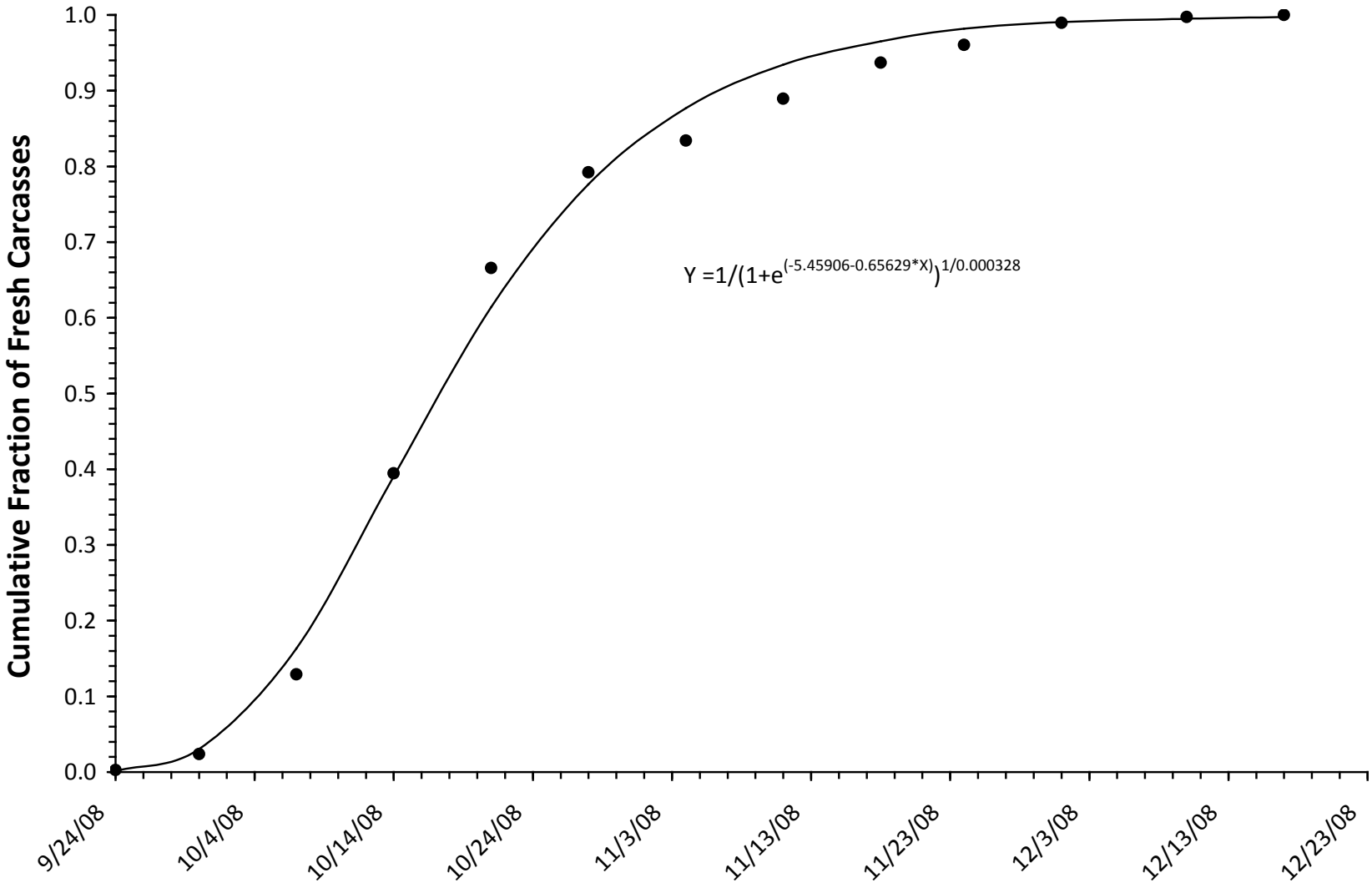

Figure 1. Cumulative fraction of fresh Chinook salmon carcasses observed by date in the lower Yuba River, CA from 9/24/2008 - 12/23/2008.

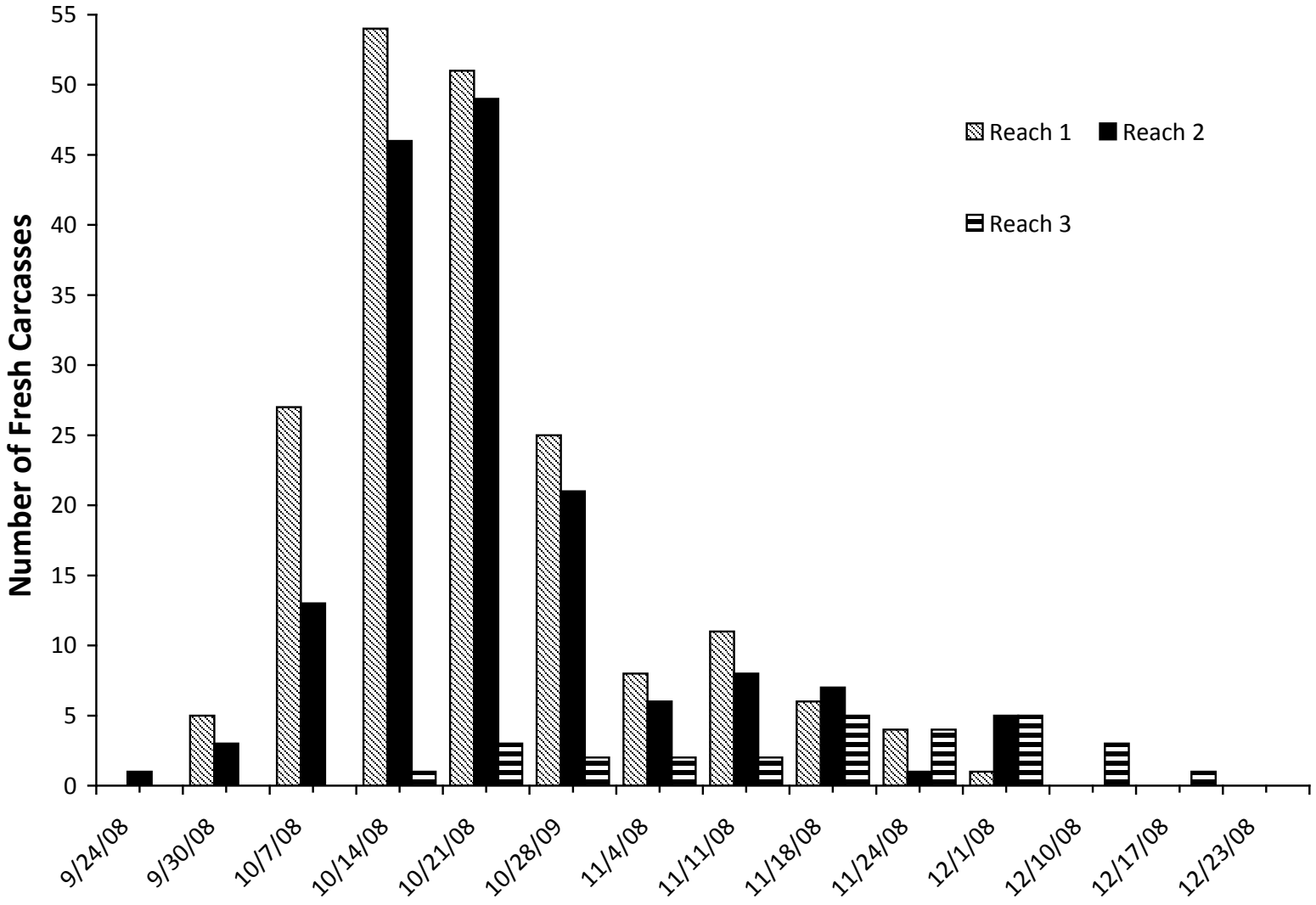

Figure 2. Temporal frequency of fresh Chinook salmon carcasses in Reach 1 (Narrows Pool to HWY 20 Bridge), Reach 2 (HWY 20 Bridge to Daguerre Point Dam (DPD)), and Reach 3 (DPD to confluence of lower Yuba River and Feather River) of the lower Yuba River, CA from 9/24/2008 - 12/23/2008.

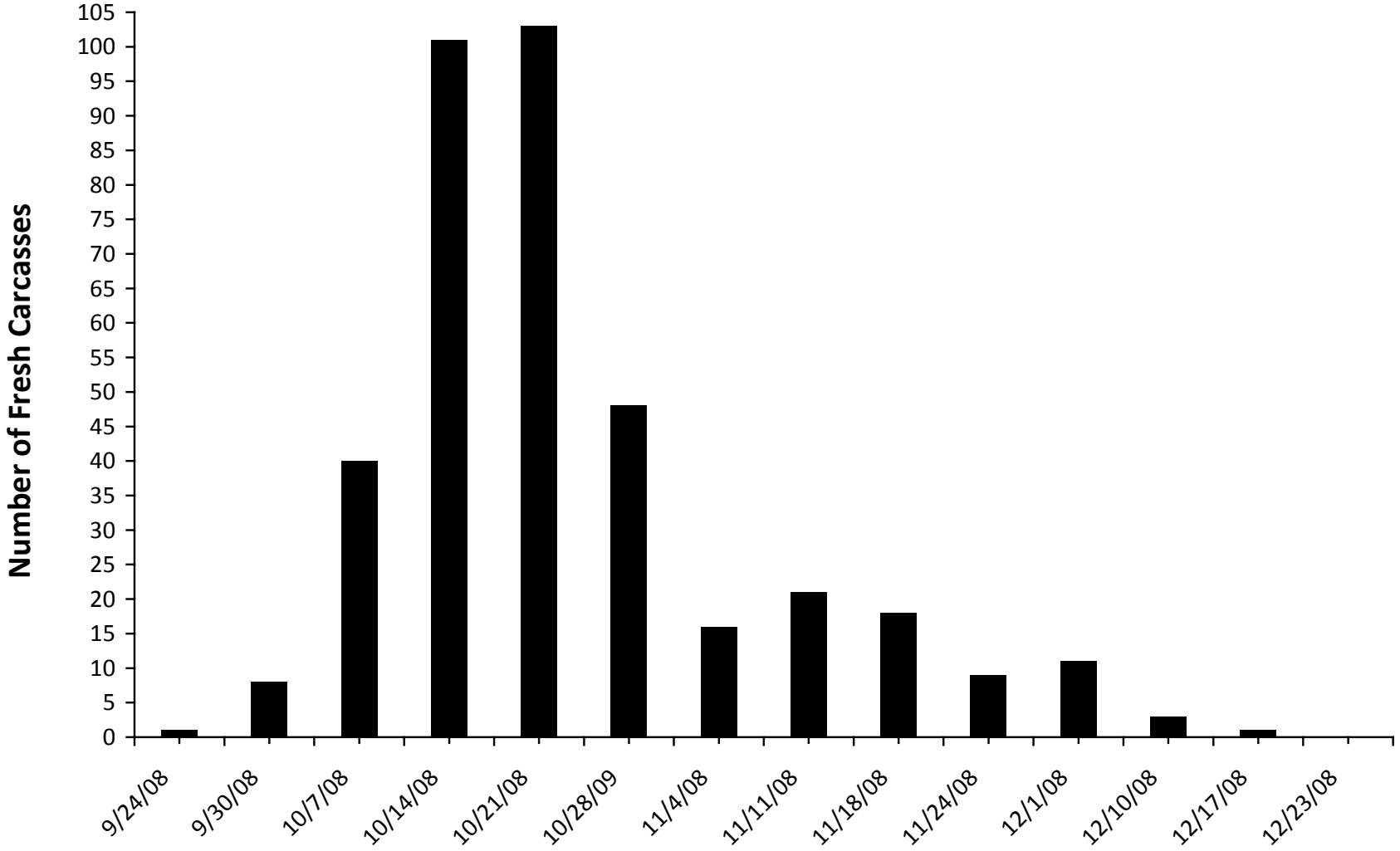

Figure 3. Weekly temporal frequency of fresh Chinook salmon carcasses observed from 9/24/2008 - 12/23/2008 in the lower Yuba River, CA.

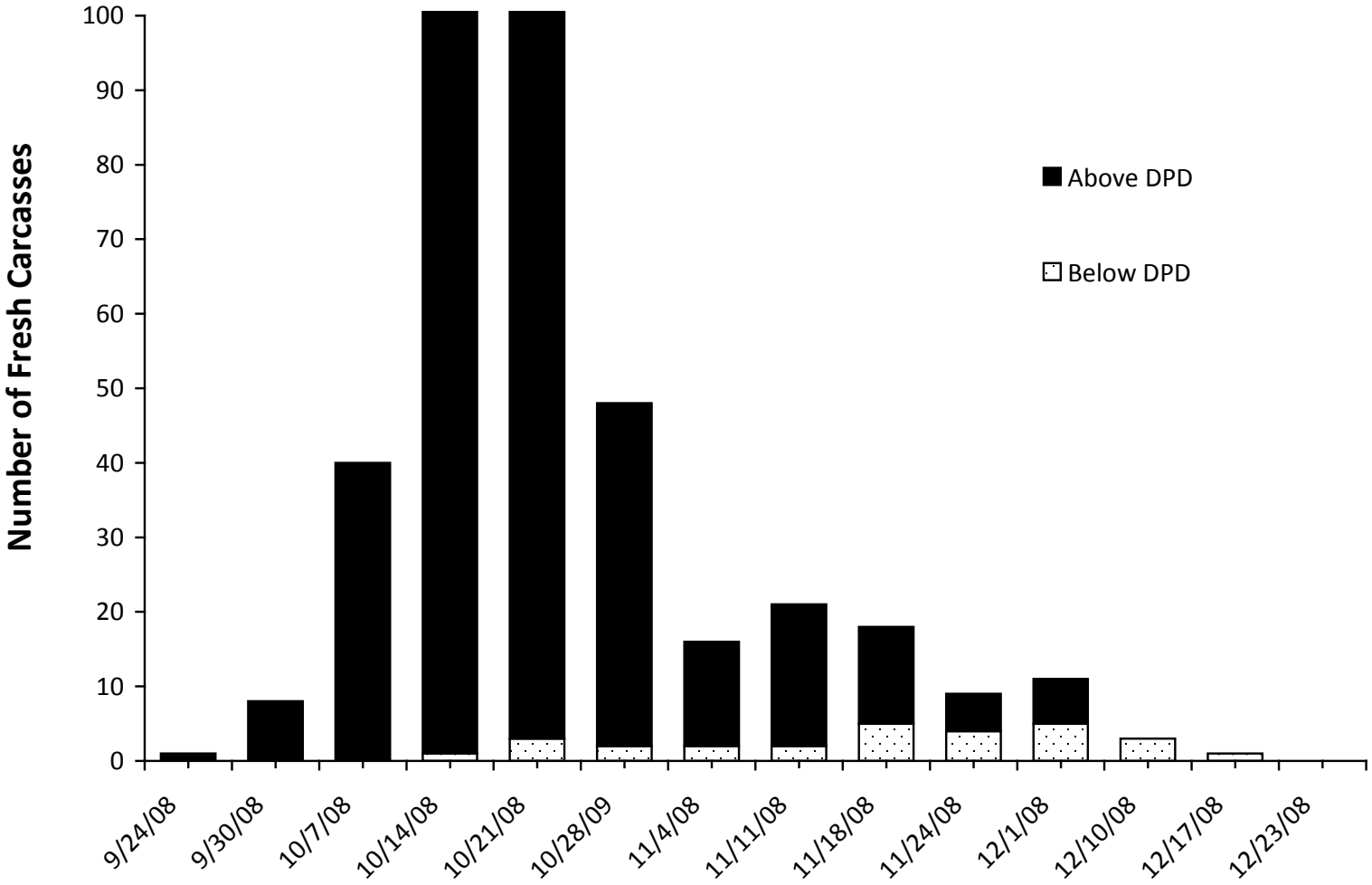

Figure 4. Frequency distribution of fresh Chinook salmon carcasses observed above Daguerre Point Dam (DPD) and below DPD in the lower Yuba River, CA from 9/24/2008 - 12/23/2008.

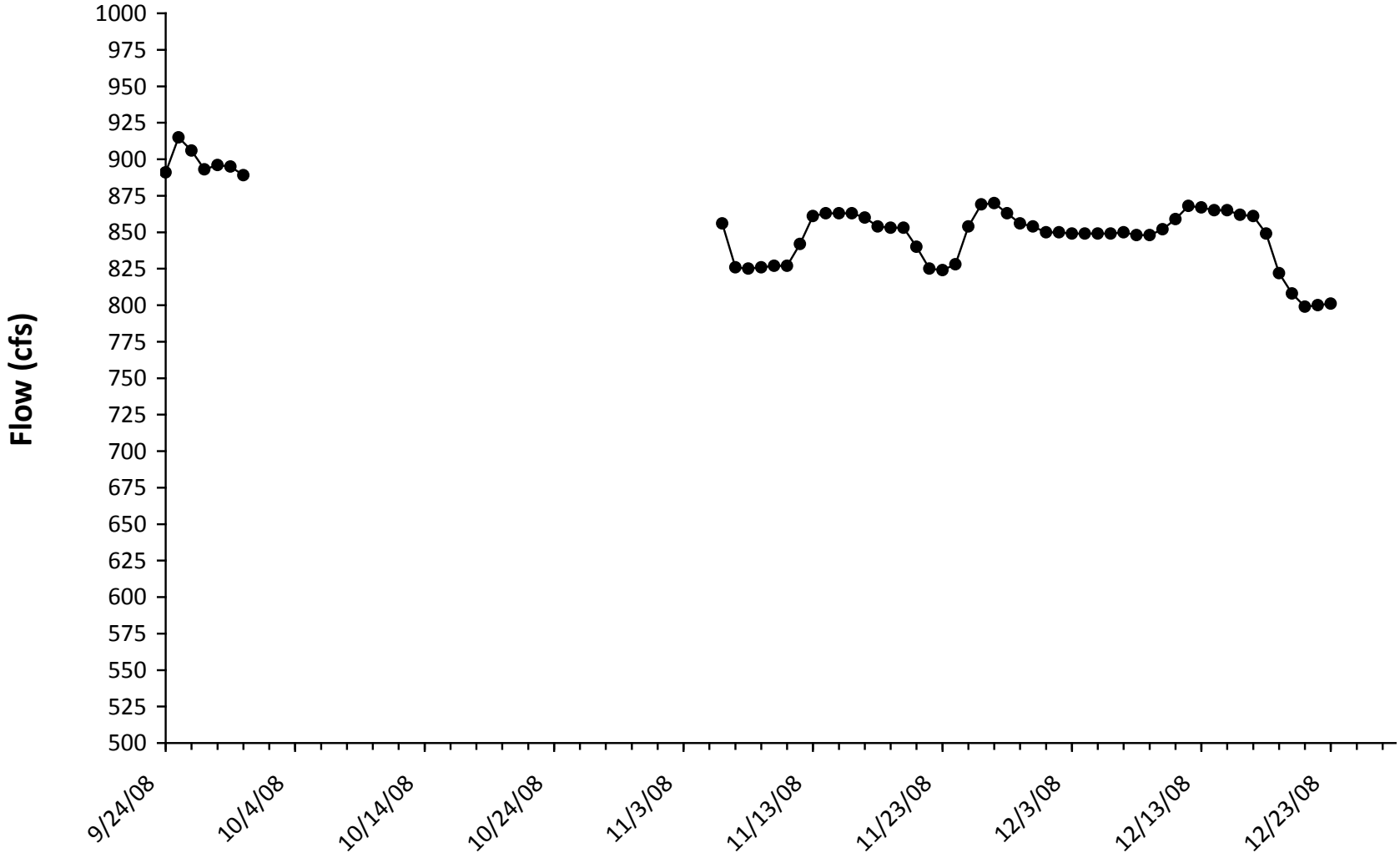

Figure 5. Mean daily flow (cfs) of the lower Yuba River measured at the USGS gauge at Smartsville, CA from 9/24/2008 - 12/23/2008.

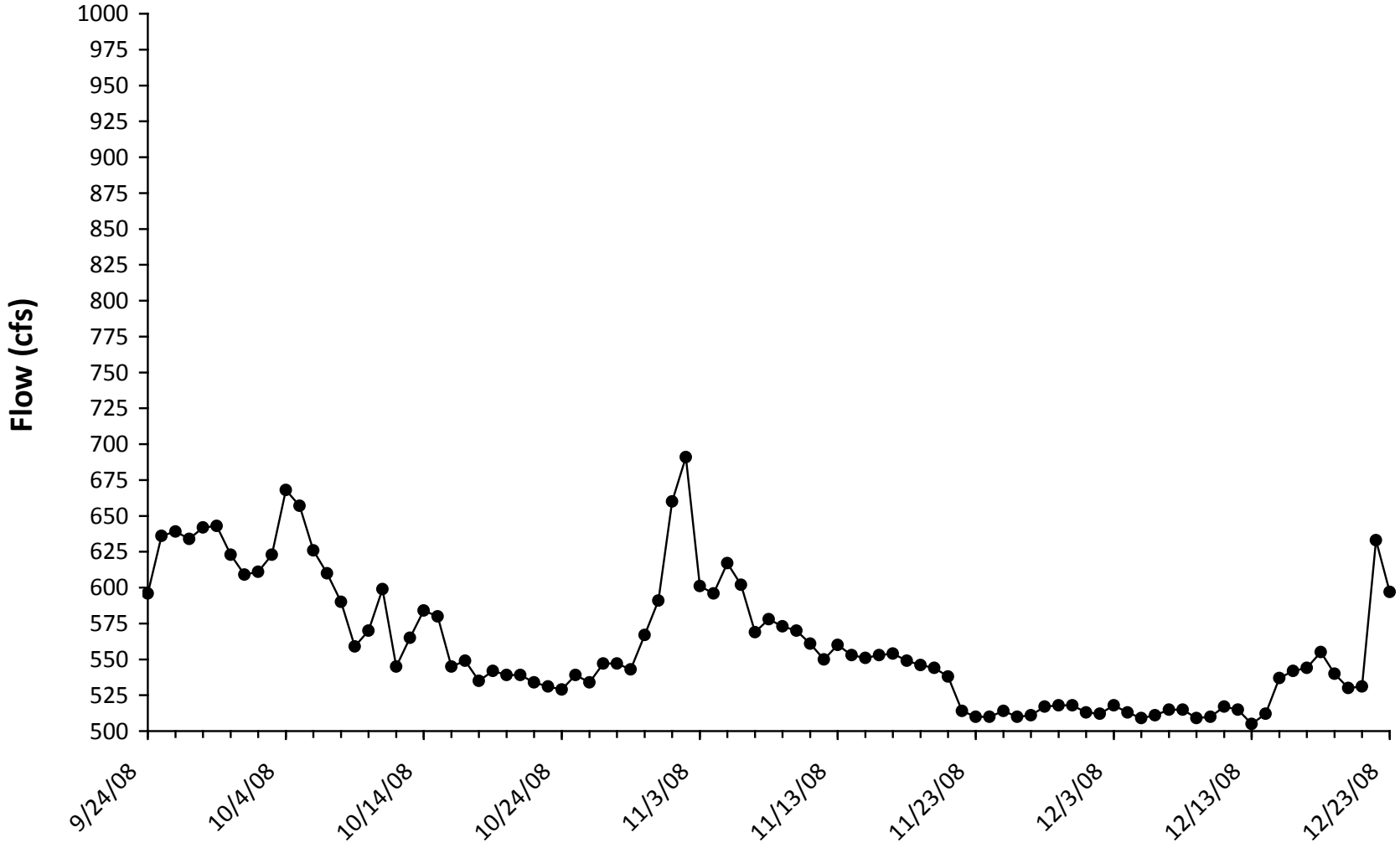

Figure 6. Mean daily flow (cfs) of the lower Yuba River measured at the USGS gauge at Marysville, CA from 9/24/2008 - 12/23/2008.

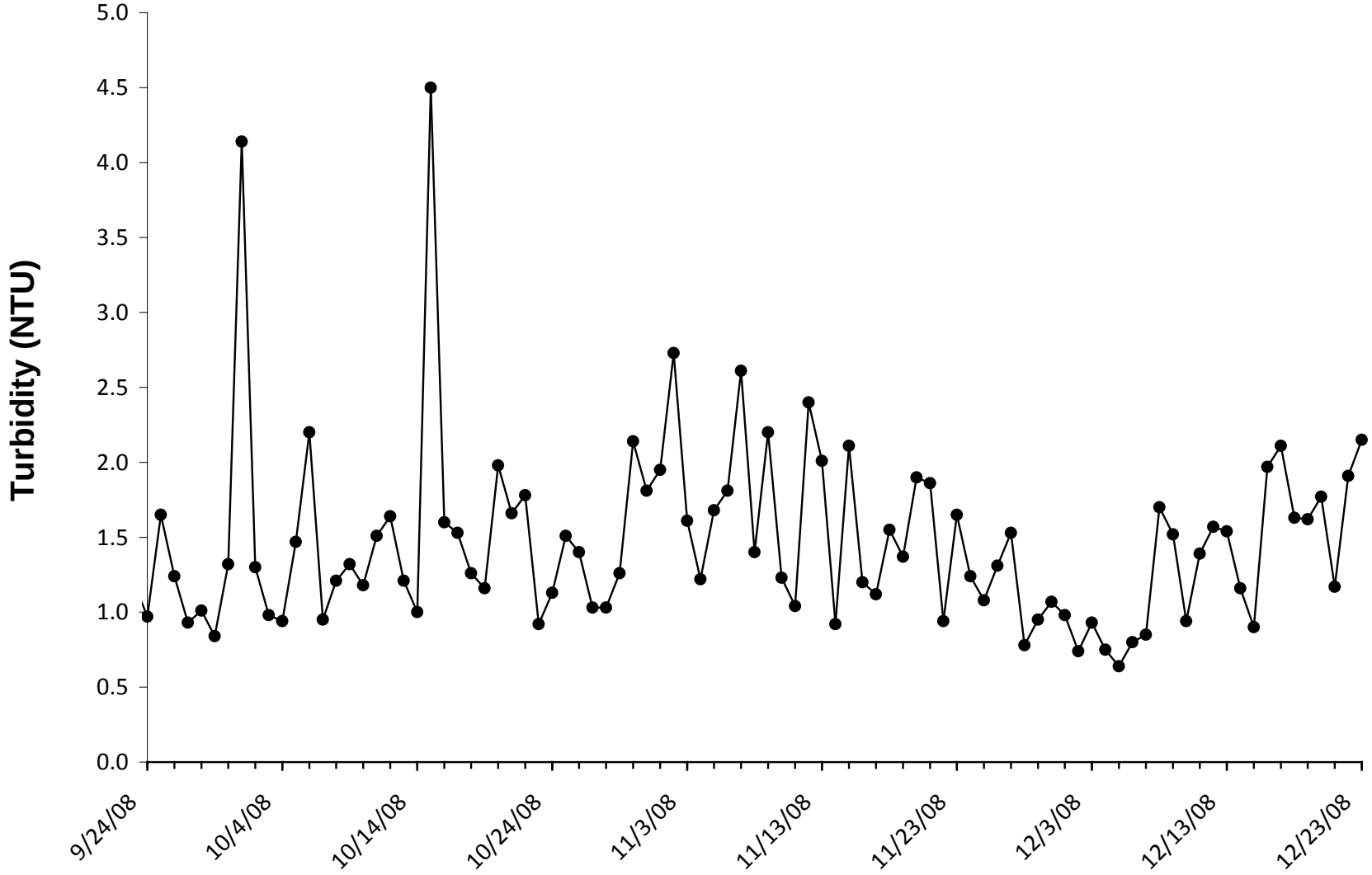

Figure 7. Turbidity (NTU) in the lower Yuba River measured at the rotary screw traps located near Hallwood Blvd. from 9/24/2008 - 12/23/2008.

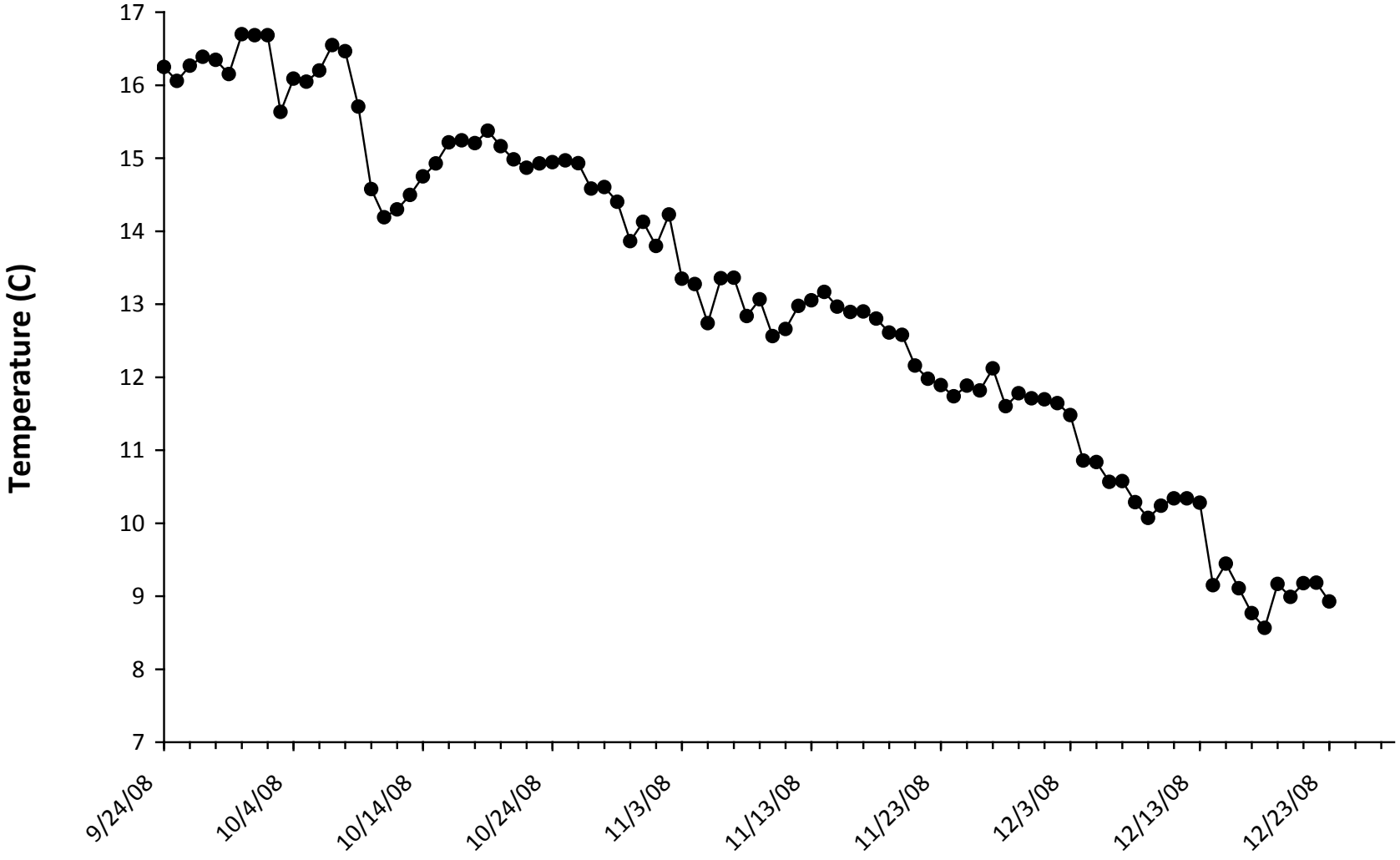

Figure 8. Mean daily water temperature (C°) of the lower Yuba River measured at the rotary screw traps near Hallwood Blvd. from 9/24/2008 - 12/23/2008.

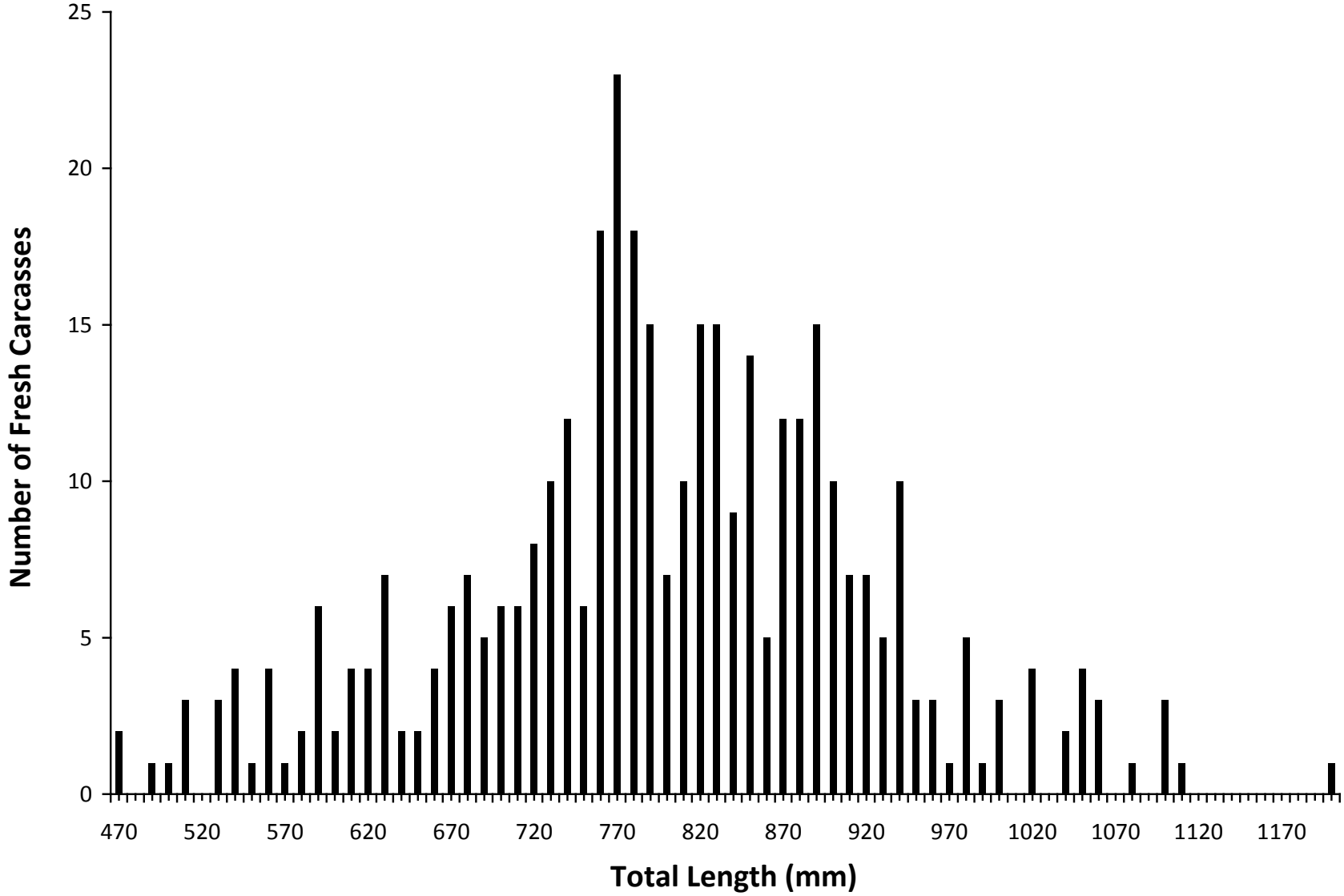

Figure 9. Length frequency distribution for all fresh Chinook salmon carcasses observed on the lower Yuba River from 9/24/2008 – 12/23/2008.

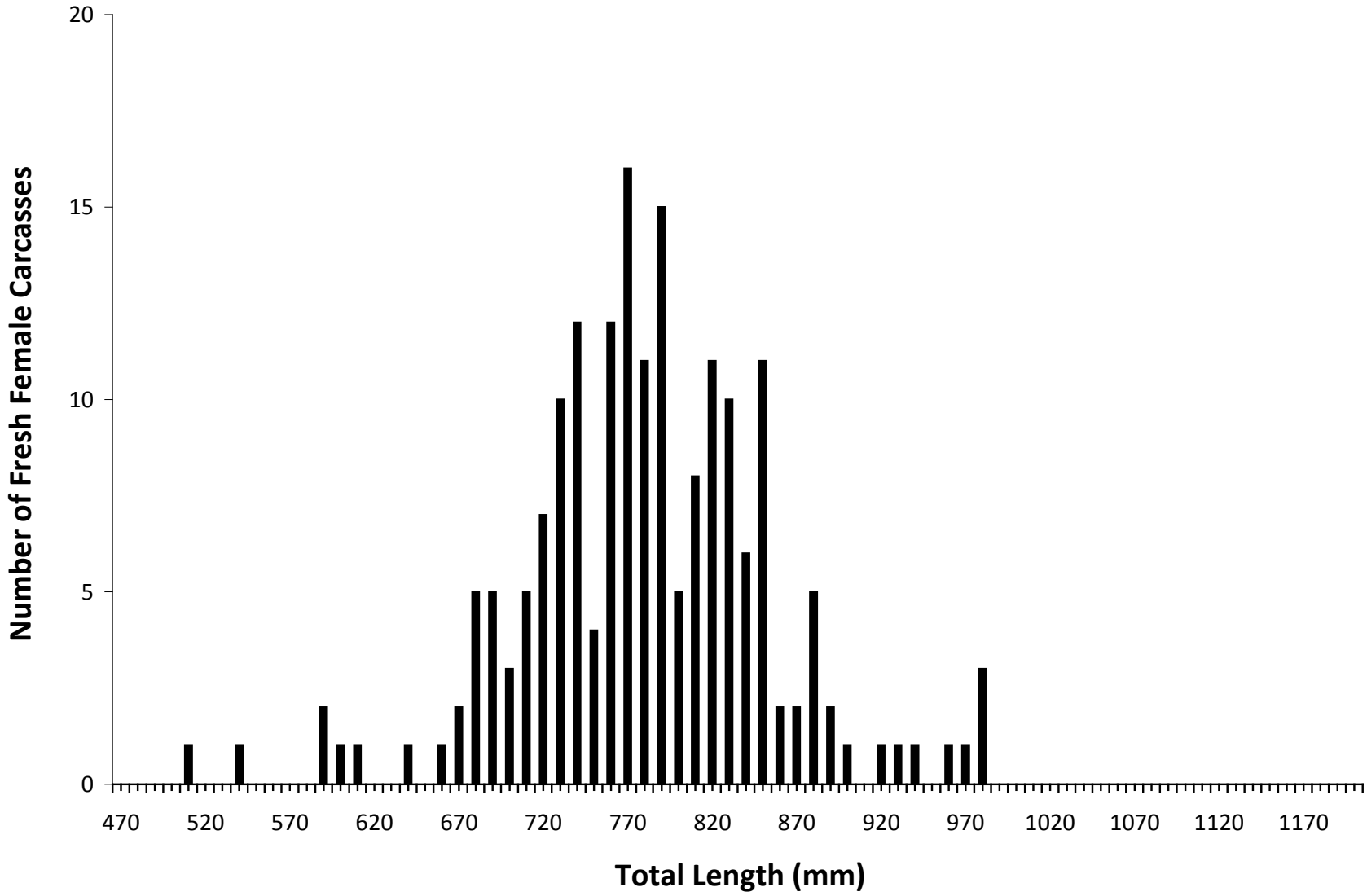

Figure 10. Length frequency distribution for all fresh female Chinook salmon carcasses (all non-adipose fin-clipped) observed on the lower Yuba River from 9/24/2008 – 12/23/2008.

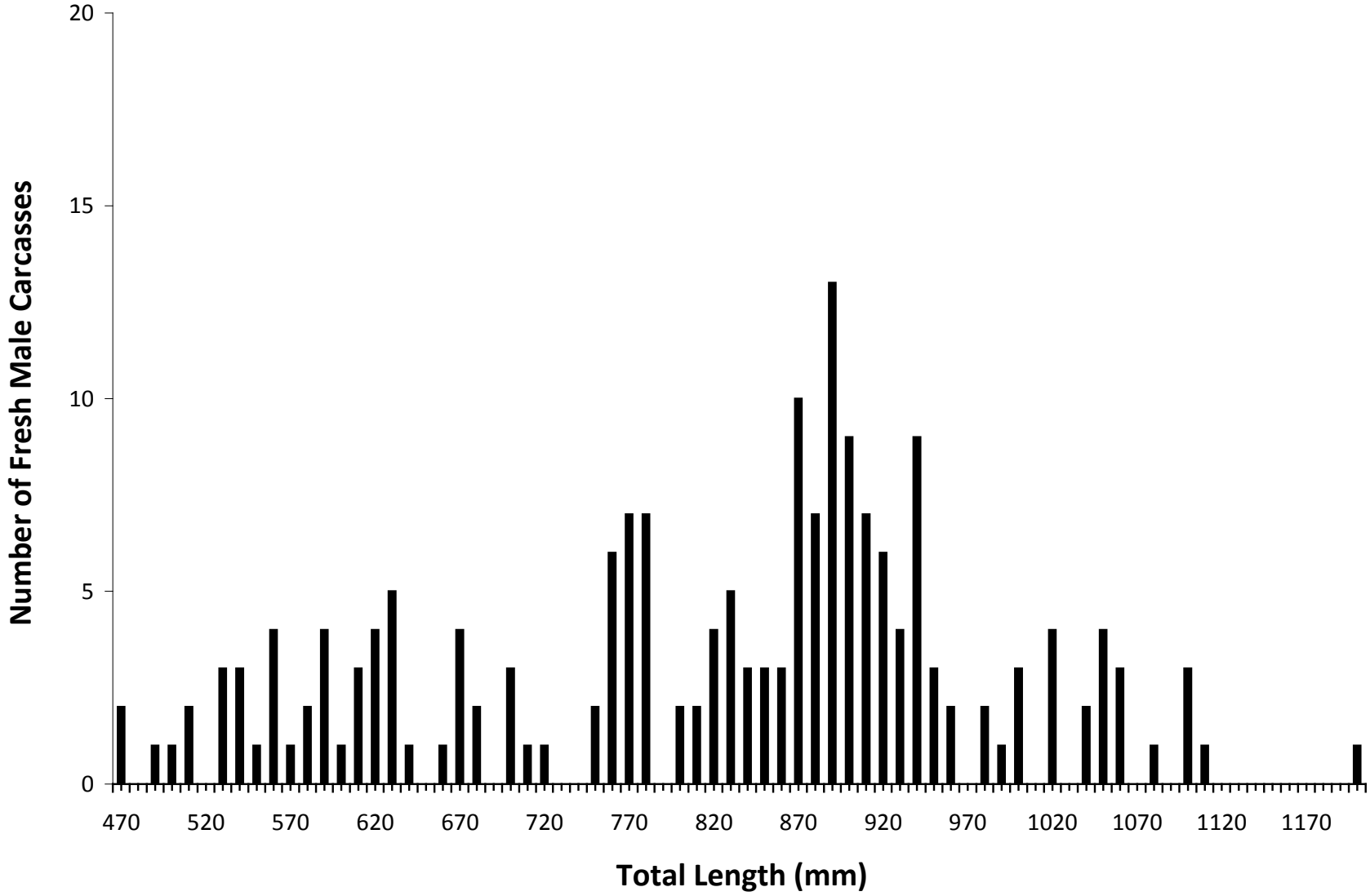

Figure 11. Length frequency distribution for all fresh male Chinook salmon carcasses observed on the lower Yuba River from 9/24/2008 – 12/23/2008.

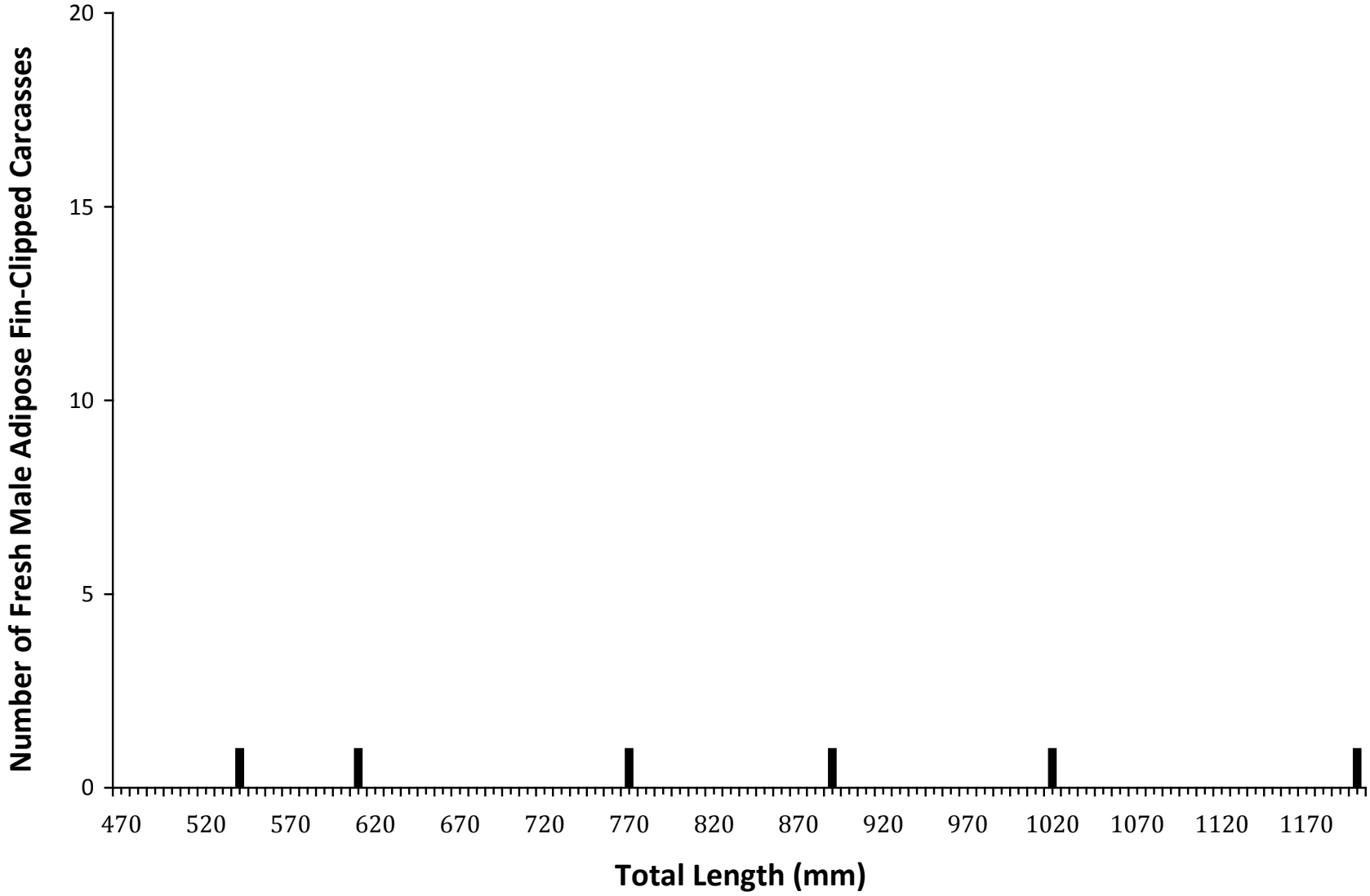

Figure 12. Length frequency distribution of adipose fin-clipped fresh male carcasses observed on the lower Yuba River from 9/24/2008 – 12/23/2008.

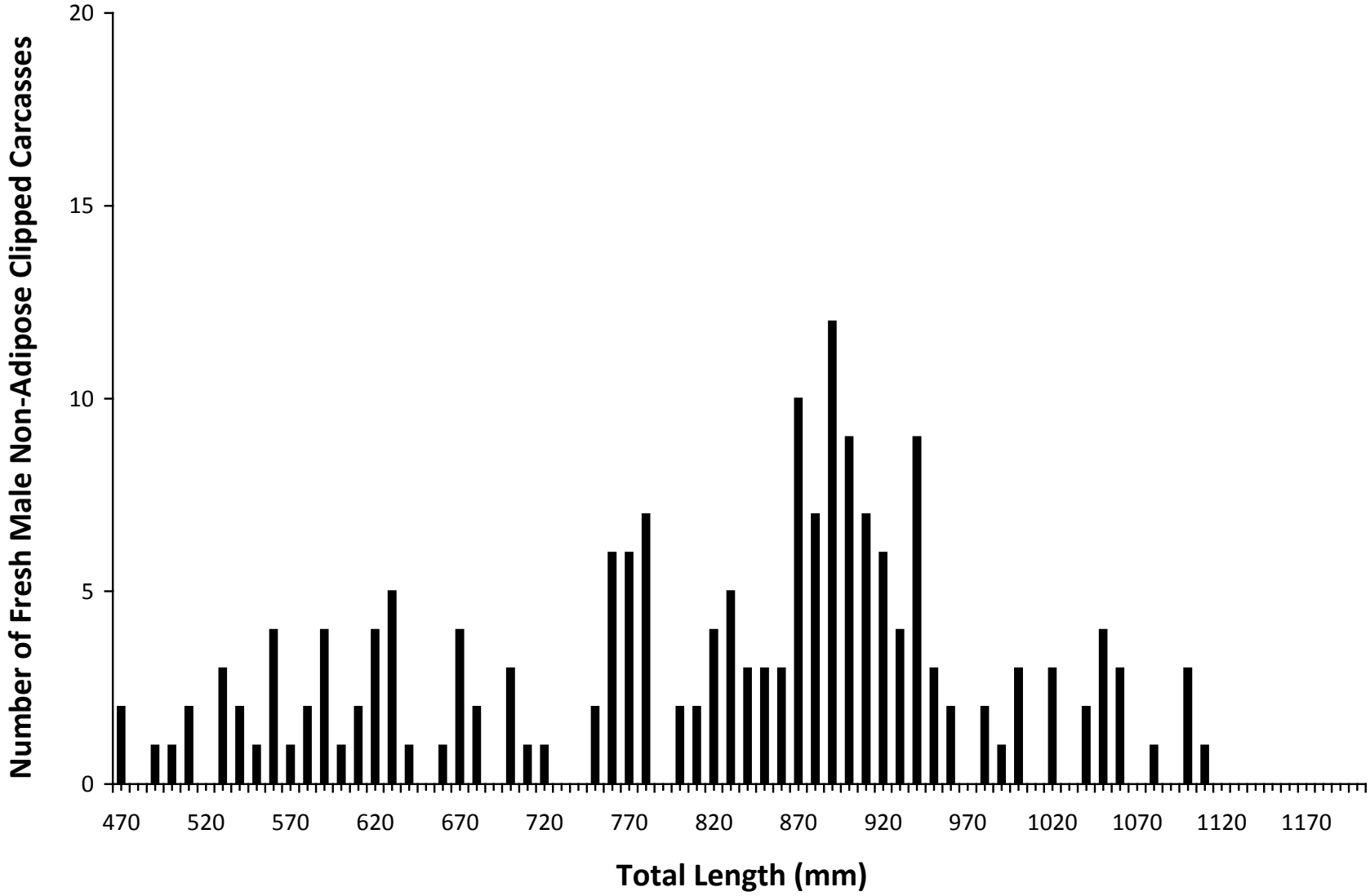

Figure 13. Length frequency distribution for non-adipose fin-clipped fresh male Chinook salmon carcasses observed on the lower Yuba River from 9/24/2008 – 12/23/2008.

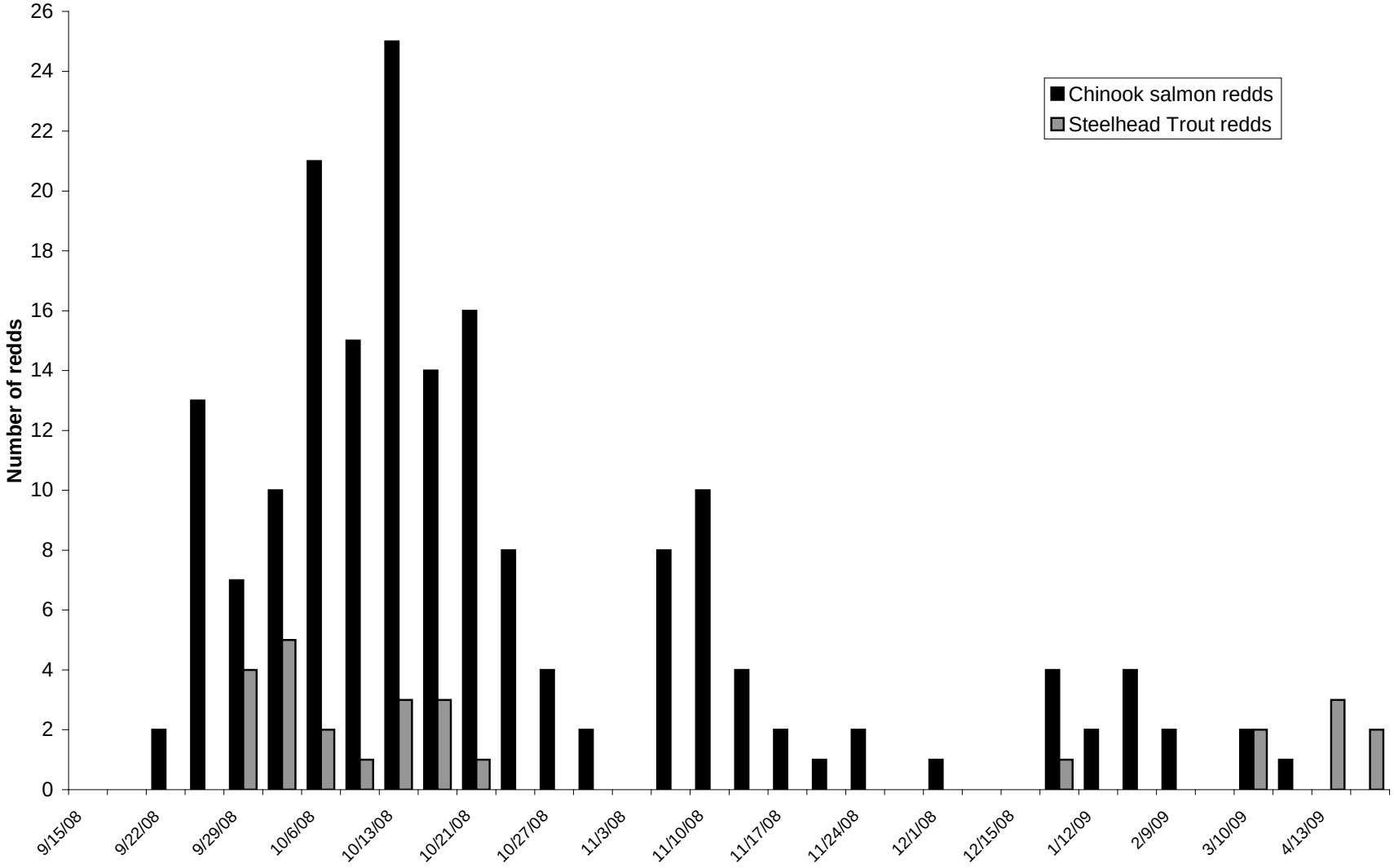

Figure 14. Frequency of Chinook salmon redds observed in the pilot redd survey indexed area in the lower Yuba River from 9/22/2008 – 4/27/2009.

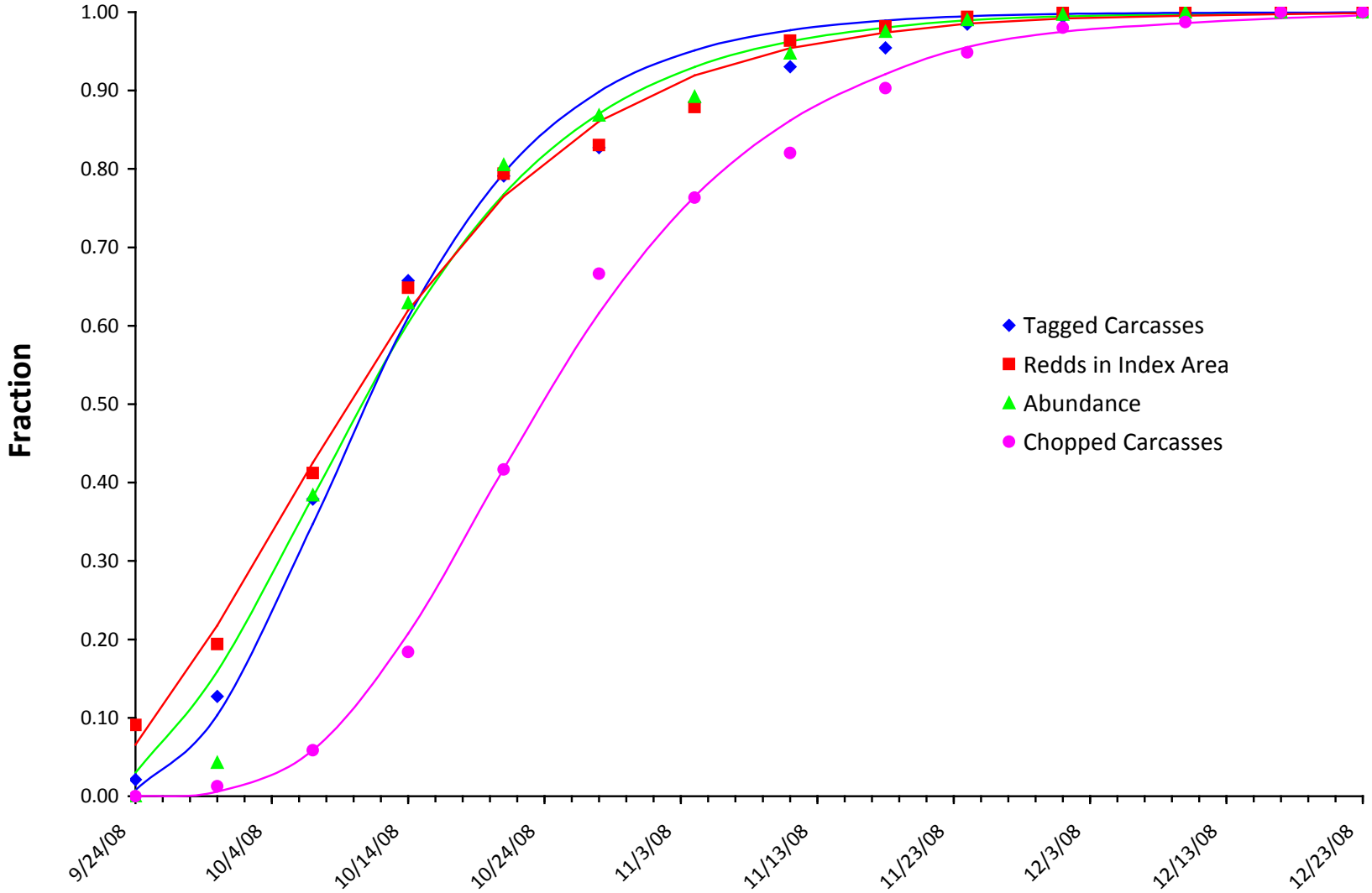

Figure 15. Cumulative fraction of Chinook salmon carcasses tagged and chopped, abundance estimated from the modified-Schaefer model, and redds observed during the pilot redd survey index area on the lower Yuba River from 9/24/2008 – 12/23/2008.

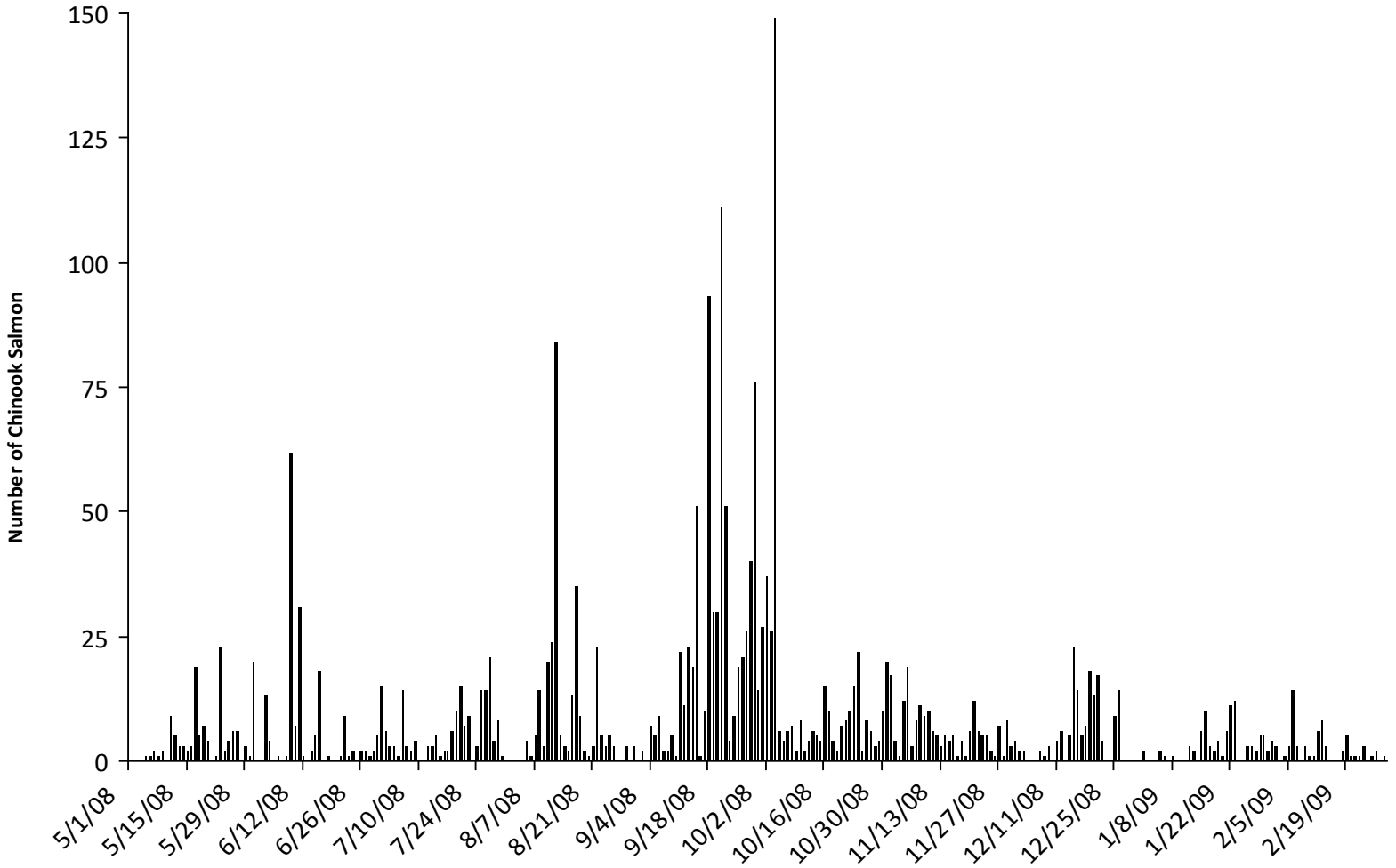

Figure 16. Frequency of Chinook salmon observed passing Daguerre Point Dam (north and south ladders) on the lower Yuba River from 5/1/2008 – 2/28/2009.