LOWER YUBA RIVER ACCORD MONITORING AND EVALUATION PROGRAM

ANNUAL REDD SURVEY REPORT

AUGUST 31, 2009 – APRIL 8, 2010

Prepared for: The Lower Yuba River Accord Planning Team

by

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The information contained in this annual data report represents study results at the date of publication. Recent analysis using multi-year data have fostered a more up-to-date understanding of lower Yuba River fisheries interactions. The results presented in this annual data report may or may not represent the current understanding stemming from recent analysis using comprehensive multi-year data. Please refer to the M&E Interim Report for a more recent analysis and discussion.

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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 (M&E 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 the 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. Analytical goals of the redd surveys conducted in the lower Yuba River include; 1) an evaluation and comparison of the spatial and temporal distribution of redds and redd superimposition over the spawning seasons for Chinook salmon and steelhead trout spawning in the lower Yuba River;, 2) a comparison of the magnitude and seasonal trends of lower Yuba River flows and water temperatures with the spatial and temporal distribution of redds (and rates of redd superimposition) for the Chinook salmon and steelhead trout;, 3) an evaluation of the total annual abundance of Chinook salmon and steelhead trout in conjunction with escapement surveys, angler surveys and Vaki Riverwatcher data;, and 4) to establish a long-term data set to be used to evaluate habitat utilization by the Chinook salmon and steelhead trout in the lower Yuba River under variable biotic and abiotic conditions.

The purpose of this Annual Lower Yuba Accord Redd Survey Data Report is to; 1) document findings for the analytics in the M&E Program that are dependent on annual data collection from redd surveys;, 2) document any deviations from the redd survey sampling protocols and procedures described in the M&E Program;, and 3) provide recommendations for changes in following year's redd survey field protocols and procedures.

1.1. Analytics Overview

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

Redd Survey Efficacy

- Examine the duration of the annual redd surveys and document temporal periods when surveys could not be implemented.

Abundance

- Evaluate the spatial and temporal distribution of redds and the temporal distribution of redd superimposition over the spawning periods for spring-, fall-, and late fall-run Chinook salmon.

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

- Estimate the number of Chinook salmon and steelhead trout redds located above and below Daguerre Point Dam (DPD).

- Examine the spatial and temporal distribution of redds over the spawning period for steelhead trout.

- Compare the magnitude of lower Yuba River flows and water temperatures with the temporal and spatial distribution of adult spring-, fall-, and late fall-run Chinook salmon and steelhead trout spawning.

- Compare the magnitude of lower Yuba River flows and water temperatures with the annual total number of redds and redd superimposition indices for Chinook salmon, taking into account the annual variability in spawning Chinook salmon abundance.

- Compare the magnitude of lower Yuba River flows and water temperatures with the annual total number of redds for steelhead trout, taking into account the annual variability in spawning steelhead trout abundance.

Diversity

- Determine temporal variation in spawning by spring-, fall-, and late fall-run Chinook salmon adults.

- Examine the timing of spring-, fall-, and late fall-run Chinook salmon spawning and, relationships between timing of spawning with water temperature and flow.

- Examine attributes for each individual redd encountered during the surveys; including the physical redd measurements, substrate and habitat characterizations.

2. FIELD METHODS

Field sampling methods are described in the Annual Redd Surveys Protocols and Procedures (Appendix I of the Accord M&E Plan).

2.1. Deviations from the Redd Survey Protocols and Procedures

Specific protocols and procedures for the annual redd surveys were developed to include a weekly survey frequency beginning at the onset of spawning in the fall and concluding on or near January 1, after which a bi-weekly sampling frequency was to be implemented. However, the weekly sampling protocol was extended and continued through the entire survey period. The protocols and procedures also required the cessation of sampling on April 30 each year. Due to high flows and sustained turbidity levels, sampling through the entire month of April 2010 was not feasible during this reporting period.

The protocols and procedures required redd size measurements to be collected at each newly constructed redd observed where an adult salmonid was either actively building, or guarding a redd. This convention was not implemented because surveyors were unable to associate individual redds with observed fish in the area. The pontoon boats used to navigate the river during surveys frightened spawning salmonids from redds prior to observation by surveyors.

Two of the 3,361 total redds observed during the survey period were recorded as polygons, rather than individual redds. A high degree of superimposition was observed in these two locations and individual redd identification within each polygon was not possible during the date of observation. No further analysis was completed to estimate the number of redds in these two polygon areas, and the polygons were treated as individual redds for analyses in this annual report. Additionally, seven individual redds observed during the week of October 19, 2009 had no associated positional data due to poor satellite coverage and were removed from all spatial/temporal, superimposition, reach and morphological unit analyses.

The substrate class size descriptions and classification systems were also modified by direction of the RMT in March 2010 to reduce observer error and to obtain a more detailed description of the undisturbed substrate elements at each redd location. Substrate descriptions and results for steelhead trout redds were reported from this modified substrate classification scheme. Substrate descriptions and results for Chinook salmon redds were reported from the previous substrate classification system.

No temperature data for the USGS Marysville gage were available for this reporting period. Temperatures recorded at the USGS Smartsville gage were used solely in this annual report.

3. DATA ANALYSIS METHODS

3.1. Redd Survey Efficacy

The duration and number of days required to implement this annual redd survey were evaluated, including temporal sampling periods and causal descriptions for missed surveys.

3.2. Abundance

An evaluation and comparison of the spatial and temporal redd distributions, including temporal distributions of redd superimposition for spring-, fall-, and late fall-run Chinook salmon spawning periods was performed. Trend analysis using simple linear regression of GIS-based spatial outputs for mapped spring-, fall-, and late fall-run Chinook salmon redds was completed during each of the run-specific spawning periods to assess the location and number of fresh redds observed during each weekly strata. Evaluations included; 1) changes in the weekly spatial distributions of the spawning locations over the entire spawning season;, and 2) changes in the weekly temporal distributions of spawning locations over the entire spawning season.

Weekly and annual indices of redd superimposition from the annual Chinook salmon redd surveys were estimated using GIS-based spatial output. The magnitude of redd superimposition was estimated using ArcGIS to quantify the percent overlap of each redd constructed in the surveyed area. Redd superimposition within each strata was expressed as the frequency of individual redds that exhibited overlap versus the total number of redds observed in the surveyed area. A trend analysis using simple linear regression of the weekly index of superimposition for spring-, fall-, and late fall-run Chinook salmon redds during each of the run-specific spawning periods was performed for the entire spawning season.

Redd data were used to enumerate Chinook salmon and steelhead trout redds observed above and below Daguerre Point Dam (DPD). The temporal and spatial distributions of spawning steelhead were identified using the number of redds observed and the redd locations documented for each survey period for the entire steelhead trout spawning season.

Chinook salmon redd observations were assigned by morphological unit for each of the eight lower Yuba River reach delineations using ArcGIS. Descriptors for each of the eight reaches have been tabulated to include measures of the valley width, best-fit bed slope, presence of tributary inflow, distance from the mouth, and a start point description (Table 1). A graphical representation has been created to illustrate depth and velocity value delineations used in conjunction with outputs from the 2D model to determine morphological units in ArcGIS (Figure 1).

Table 1. Reach descriptors developed by the RMT from LIDAR-based topographic mapping and 2D flow modeling on the lower Yuba River, CA (Appendix I, Lower Yuba River Accord Monitoring and Evaluation Plan).

Reach Name	Valley Width (m)			Best-Fit Bed Slope	Tributary Inflow?	Thalweg Distance from Mouth (km)	Start Point
	Min.	Mean	Max.				
Englebright Dam Reach	55	95	176	0.310%	No	n/a	Englebright Dam
Narrows Reach	n/a	n/a	n/a	n/a	Yes	n/a	Deer Creek Confluence
Timbuctoo Bend Reach	97	166	411	0.201%	No	31.1 - 37.4	Onset of Emergent Gravel Floodplain Upstream of Blue Point Mine
Parks Bar Reach	95	297	434	0.188%	No	23.2 - 31.1	State Route 20 Bridge
Dry Creek Reach	239	308	490	0.135%	Yes	19.4 - 23.2	Dry Creek Confluence
Daguerre Point Dam Reach	198	449	554	0.176%	No	13.7 - 23.2	Daguerre Point Dam
Hallwood Reach	71	271	569	0.131%	No	5.3 - 13.7	Eddie Drive aims at Slope Break
Marysville Reach	68	171	381	0.052%	No	0 - 5.3	No Evident Feature

Table 2. Depth and velocity value delineations used in conjunction with NAIP aerial imagery, topography, contours, sediment mapping and the GIS 2D (SRH-2D) model to determine morphological units in the lower Yuba River, CA (courtesy Josh Wyrick, PhD and Greg Pasternack, PhD – U.C. Davis).

Morphological Unit	Description
Bedrock	Bedrock outcropping at elevation greater than the valley to slope break.
Chute	Area of high velocity, steep water surface slope, and moderate to high depth located in the channel thalweg. Chutes are often located in a convergent constriction downstream of a riffle as it transitions into a run, forced pool, pool, or glide. Depths exceed 2.25 ft (0.69 m) and velocities exceed 3 ft/s (0.91 m/s).
Cutbank	Steep bank that is eroding heavily. Often located on the outside of a meander bend. Can be composed of either gravel/cobble alluvium or angular hillslode rocks and boulders, depending on the location of occurrence.
Fast Glide	Area of moderate velocity and depth and low water surface slope. Depth can range from 2.25-4.6 ft (0.69-1.4 m). Commonly occur along periphery of channel and flanking pools. Also exist in straight sections of low bed slope.
Floodplain	Area located at an elevation higher than the bankful channel and lower than that of the valley toe slope break.
Hillside	Natural colluvium at an elevation greater than the valley toe slope break.
Lateral Bar	Area located at the channel margins at an elevation band between the autumnal low-flow stage and bankful stage. Lateral bars are orientated parallel to the flow. The feature slopes toward the channel thalweg with an associated increase in both flow depth and velocity when submerged. Sediment size tends to be smaller than in adjacent sections of the channel.
Medial Bar	Emerged bar surrounded by water at low discharge. Higher flows may temporarily submerge the bar.
Point Bar	Area located on the inside of a meander bend at an elevation band between the autumnal low-flow stage and bankful stage. Point bars are curved and begin where there is clear evidence of point-bar deposition. The feature slopes toward the channel thalweg with an associated increase in both flow depth and velocity when submerged. Sediment size tends to be smaller than in adjacent sections of the channel.
Pond	Located on the floodplain and not attached to the main channel by a surface opening during low flow
Pool / Forced Pool	Pools are areas of high depth and low velocity, specifically for water depth > 4.6 ft (1.4 m) and velocity < 2.0 ft/s (0.61 m/s), and low water surface slope. A 'forced pool' is one that is typically along the periphery of the channel and is "over-deepened" from local convective acceleration and scour during floods that is associated with static structures such as wood, boulders, and mostly bedrock outcrops (Montgomery and Buffington, 1997; Thompson et al., 2001). A 'pool' is not formed by a forcing obstruction.
Riffle	Area with shallow depths of <2.25' (0.69 m), moderate to high velocities greater than 2 ft/s (0.61 m/s), rough water surface texture, and steep water surface slope. Riffles are associated with the crest and backslope of a transverse bar.

Riffle Transition	Typically a transitional area between an upstream morphological unit into a riffle, or from a riffle into a downstream morphological unit. Water depth is relatively low, ranging from 0-2.25 ft (0.69 m). Velocity is low, ranging from 1-2 ft/s (0.3-0.61 m/s), but increases downstream due to convective acceleration toward the shallow riffle crest that is caused by lateral and vertical flow convergence. The upstream limit is at the approximate location where there is a transition from a divergent to convergent flow pattern. The downstream limit is at the slope break of the channel bed termed the riffle crest.
Run	Area with a moderate velocity, between 2 and 3 ft/s (0.61 and 0.91 m/s), and moderate water surface slope. Depths are greater than 2.25 ft (0.69 m). Runs typically occur in straight sections that exhibit a moderate water surface texture and tend not to be located over transverse bars.
Slackwater	Shallow, low-velocity regions of the stream that are typically located in adjacent embayments, side channels, or along channel margins. Velocities are near stagnant, less than 0.5 ft/s (0.15 m/s), and depths can range from 0-4.6 ft (1.4 m).
Slow Glide	Area of low velocity and low to moderate depths and low water surface slope. Velocities range from 0.5 - 1.0 ft/s (0.15-0.3 m/s) and depths are less than 4.6 ft (1.4 m). May be located near water's edge as a morphological unit along the channel thalweg transitions laterally towards the stream margins
Swale	A poorly defined geometric channel located in the floodplain adjacent to the main channel, but does not contain water at low discharge. Higher discharges will overflow into the channel due to backwater effects in the main stem.
Tailings	Alluvium artificially piled up to an elevation higher than the floodplain surface during historic dredging for gold.
Terrace	A natural alluvial deposit at an elevation higher than the floodplain surface.
Tributary Channel	Waterway that confluences with the main channel and whose headwater source is separate from the main channel. The mouth of the tributary channel may backwater during high flow events in the main channel.
Tributary Delta	Alluvial fans penetrating the floodplain and main channel at tributary junctions.

Potential relationships between flow, temperatures and peak spawning for spring-, fall-, and late fall-run Chinook salmon and steelhead trout were examined using estimated peak spawning periods derived from the temporal redd distributions observed. Flow and water temperature observations were described using various metrics (e.g., maximum, minimum, average, median and variance of mean daily flow) during the spring-, fall-, and late fall-run Chinook salmon and steelhead trout spawning periods. Simple linear regression was used to examine potential relationships between multi-year peak spawning periodicities (response variable) and corresponding flow and water temperature metrics (explanatory variables). Dates associated with percentile expressions (1%, 10%, 25%, 50%, 75%, 90% and 99%) of the cumulative temporal distribution of spring-, fall-, and late fall-run Chinook salmon and steelhead trout spawning were identified by fitting an asymmetric logistic function to the cumulative temporal distribution of fresh redds from the redd survey data (Richards 1959):

$$\sum_{i=1}^{D_i=n} Y_i(\%) = 100 \times \left(\frac{1}{1+\exp\left(\alpha + \beta \times D_i\right)} \right)^{\frac{1}{\delta}};$$

where $\sum_{i=1}^{D_i=n} Y_i(\%)$ is the percentage of the cumulative temporal distribution of each run of Chinook salmon and steelhead trout spawning from day 1 through time D_i, and α, β and δ are parameters (i.e., constants) that describe the shape of the resulting relative cumulative curve. The values of these parameters were obtained through non-linear least squares estimation. Once the asymmetric logistic function curve was fitted to the data, the dates at which a particular percentage (X) of each run of Chinook salmon and steelhead trout spawning ($\hat{D}_{X\%}$) was identified using the inverse estimation:

$$\hat{D}_{X\%} = \frac{\log_e\left(\frac{100}{X^{\delta}} - 1 \right) - \alpha}{\beta};$$

where α, β and δ were the parameter values obtained from the asymmetric logistic function, and *X* was the percentage of interest (e.g., 1%, 10%, 25%, 50%, 75%, 90% and 99%). For example, the resulting estimates of $\hat{D}_{10\%}$, $\hat{D}_{25\%}$, $\hat{D}_{50\%}$, $\hat{D}_{75\%}$ and $\hat{D}_{90\%}$ summarized the characteristics of the corresponding annual temporal distribution of spawning adult salmonids.

Potential relationships between the timing of spawning with the magnitude of flow and water temperature were examined by plotting the dates associated with the percentile expressions (1%, 10%, 25%, 50%, 75%, 90% and 99%) of the cumulative temporal redd distribution for spring-, fall-, and late fall-run Chinook salmon and steelhead trout against various flow and water temperature metrics (e.g., maximum, minimum, average, median and variance of mean daily flow). Simple linear regression was used to examine potential relationships between periodicities associated with the percentile expressions for spawning (response variable) and corresponding flow and water temperature metrics (explanatory variables).

3.3. Diversity

The temporal distribution of Chinook salmon and steelhead trout spawning was examined against flow and temperature in the lower Yuba River. Temporal periods associated with percentile expressions (1%, 10%, 25%, 50%, 75%, 90% and 99%) for the cumulative temporal distributions of spring-, fall-, and late fall-run Chinook salmon and steelhead trout spawning were examined. The estimated dates associated with percentile expressions were plotted against standard metrics (e.g., maximum, minimum, mean, median and variance) of flow or water temperature, and relationships were examined using regression analysis.

Redd data were used to examine Chinook salmon and steelhead trout redd physical attributes. Redd size was described using standard metrics (e.g., maximum, minimum, mean, median and variance of redd measurements).

Redd attribute data was used to examine substrate characterizations for Chinook salmon and steelhead trout. Substrate characterizations were described using standard metrics (e.g., maximum, minimum, mean, median and variance of substrate characterizations).

4. RESULTS

4.1. Redd Survey Efficacy

The 2009-2010 redd survey commenced on August 31, 2009 following preliminary field reconnaissance surveys that observed redd construction and Chinook salmon adults staging in known spawning areas. Redd surveys continued uninterrupted through October 12, 2009 when precipitation and runoff from an early storm caused turbidity levels to rise, suspending the weekly survey. Surveys resumed on October 19, 2009 continuing uninterrupted until January 18, 2010 when storm precipitation and runoff caused turbidity levels to rise and remain elevated until surveys resumed on February 15, 2010. On March 1, 2010, the weekly redd survey was suspended due to winter storm runoff. Redd surveys resumed on March 8, 2010 continuing uninterrupted through the week of April 5, 2010 after which winter storm precipitation and runoff caused turbidity levels to rise and precluded sampling through the remainder of April 2010.

Results were tabulated for each weekly strata including the number of survey days required to complete all surveyed reaches, the mean weekly Secchi depth measurement, the minimum, maximum and mean of flows at the USGS Smartsville and Marysville gages, and water temperatures recorded at the USGS Smartsville gage (Appendix A, Table A1).

4.2. Abundance

A total of 3,361 Chinook salmon redds were observed during the survey period. Peak observations of Chinook salmon redds for all surveyed reaches occurred during the week of October 19, 2009 when 573 Chinook salmon redds were observed in the surveyed reaches of the lower Yuba River[2] (Figure 1, Appendix A, Table A2). Chinook salmon redds were most frequency observed at river mile (RM) 15 (n=401), RM 20 (n=297) and RM 21 (n=511); accounting for 36% of the observed Chinook salmon redds in all surveyed reaches (Appendix A, Tables A3-A6).

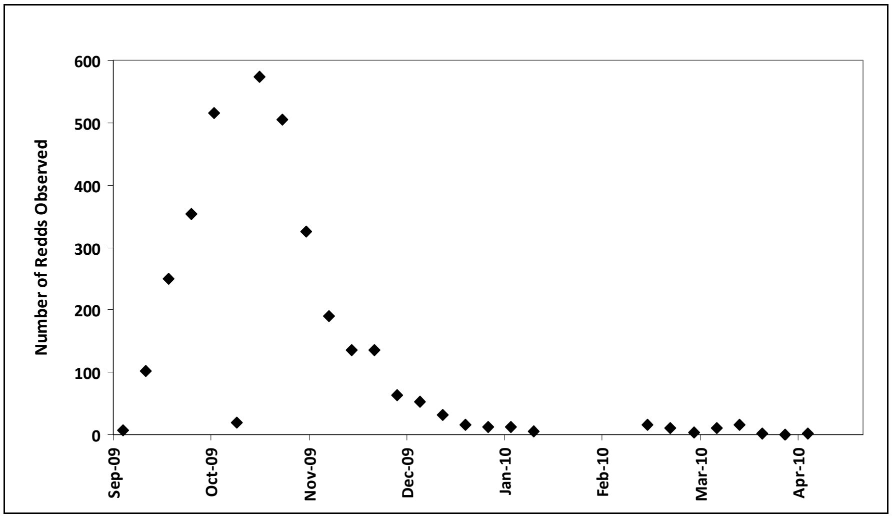

Figure 1. Weekly number of observed Chinook salmon redds in the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

GIS spatial analysis of Chinook salmon redds identified that 62% of all redds were observed in riffle and run morphological unit delineations. Redds constructed in riffle units represented 42.7% (n=1,432) of the observed redds, whereas redds constructed in runs constituted 19.3% (n=648) of the observed totals (Table 3). No Chinook salmon redds were observed in bedrock, cutbank, floodplain, pond, tailings, terrace, tributary channel or tributary delta morphological units and were not included in Table 3. Nearly 67% of Chinook salmon redds were observed in the Timbuctoo Bend and Parks Bar reaches. Redds constructed in the Timbuctoo Bend reach represented 34.1% (n=1,145) of the observed Chinook salmon redds, whereas redds constructed in the Parks Bar reach constituted 32.5% (n=1,090) of the cumulative total observed in all surveyed reaches (Table 3).

[2] See discussion page 15.

Table 3. Number of observed Chinook salmon redds stratified by morphological unit in each of the eight reach delineations of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Morphological Unit	Englebright Dam Reach	Narrows Reach[1]	Timbutoo Bend Reach	Parks Bar Reach	Dry Creek Reach	Daguerre Dam Reach	Hallwood Reach	Marysville Reach	TOTALS	Percent
Chute	0	n/a	55	67	11	13	3	1	150	4.5%
Fast Glide	4	n/a	144	45	12	5	10	0	220	6.6%
Hillside	0	n/a	0	1	0	0	0	0	1	0.0%
Lateral Bar	10	n/a	7	8	1	14	3	0	43	1.3%
Medial Bar	0	n/a	0	0	2	0	0	0	2	0.1%
Point Bar	0	n/a	10	11	0	4	0	0	25	0.7%
Pool	0	n/a	10	0	2	0	0	0	12	0.4%
Riffle	8	n/a	390	492	43	358	128	13	1,432	42.7%
Riffle Transition	3	n/a	218	135	26	126	67	4	579	17.3%
Run	1	n/a	254	281	41	27	38	6	648	19.3%
Slackwater	2	n/a	27	10	9	19	2	0	69	2.1%
Slow Glide	1	n/a	30	39	6	21	4	0	101	3.0%
Swale	0	n/a	0	0	0	0	0	0	0	0.0%
No MU ID[2]	0	71	0	1	0	0	0	0	72	2.1%
TOTALS	29	71	1,145	1,090	153	587	255	24	3,354	100.0%
Percent	0.9%	2.1%	34.1%	32.5%	4.6%	17.5%	7.6%	0.7%	100.0%	

[1] No morphological unit delineation yet exists for the Narrows Reach. [2] One redd in the Parks Bar Reach lied outside the current delineated MU map.

A total of 2,495 Chinook salmon redds were observed upstream of Daguerre Point Dam (DPD) during the survey period, whereas 866 were observed downstream of DPD. Peak observations of Chinook salmon redds upstream of DPD occurred during the week of October 5, 2009 when 480 Chinook salmon redds were observed (Appendix A, Table A2). Peak observations of Chinook salmon redds downstream of DPD occurred during the week of October 26, 2009 when 152 Chinook salmon redds were observed.

Simple linear regressions to assess redd abundance by river mile during each weekly stratum exhibited weak relationships between response and explanatory variables, with the strongest correlations between variants occurring either early in the survey period, or after combining all cumulative strata (Appendix A, Table A7).

A simple linear regression of Chinook salmon superimposition frequency for each weekly strata (Appendix A, Table A8) produced a positive relationship between response and explanatory variables moving through the survey period. The resulting regression described nearly 45% of the observations (Figure 2).

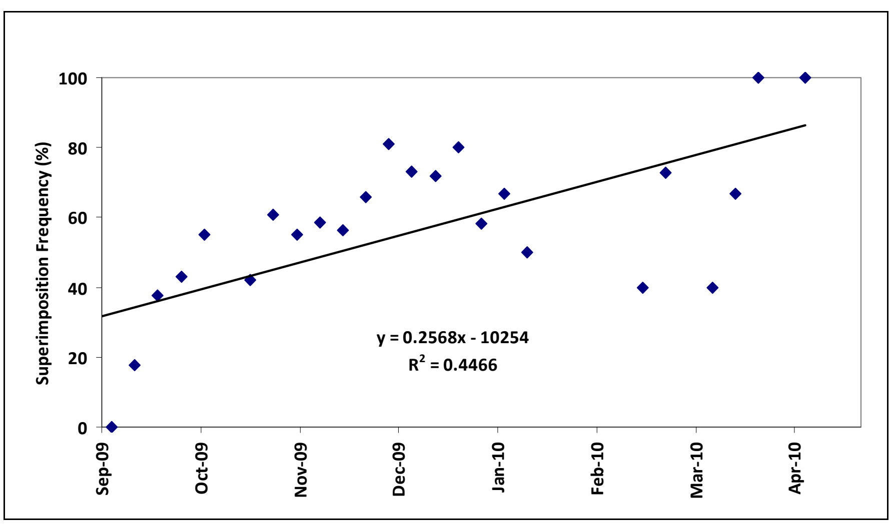

Figure 2. Simple linear regression of the weekly frequency of superimposition for Chinook salmon in the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Redd superimposition analysis using ArcGIS demonstrated that 2,532 of the 3,354 redds exhibited a measureable degree of superimposition, 1,252 were found to have a level of superimposition greater than 50%[3] (Appendix A, Tables A9-A16). The highest frequency of superimposed Chinook salmon redds were found to occur at RM 15 (n=338), RM 20 (n=262) and RM 21 (n=431) (Appendix A, Tables A17-A24).

A fitted asymmetric logistic function predicted that 50% of Chinook salmon spawning was observed by October 19, 2009, with 90% of the observations occurring by November 23, 2009 (Figure 3). The predicted date associated with the percentile expressions for Chinook salmon was plotted against mean daily flow and water temperatures for each corresponding stratum (Figure 4). The resulting figure illustrated decreasing flows at the USGS Marysville gage through the percentile expressions. Flow at the USGS Smartsville gage fluctuated throughout the percentile expressions, whereas temperatures decreased.

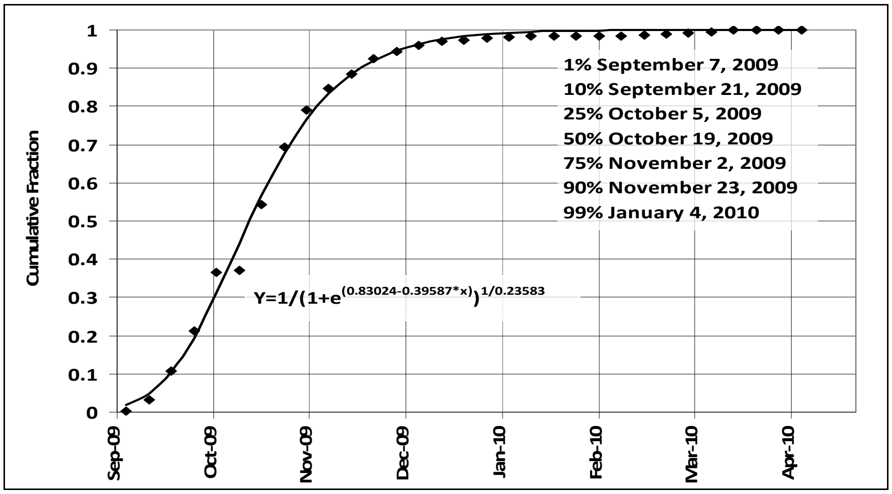

Figure 3. Cumulative temporal distribution of observed Chinook salmon redd abundance in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

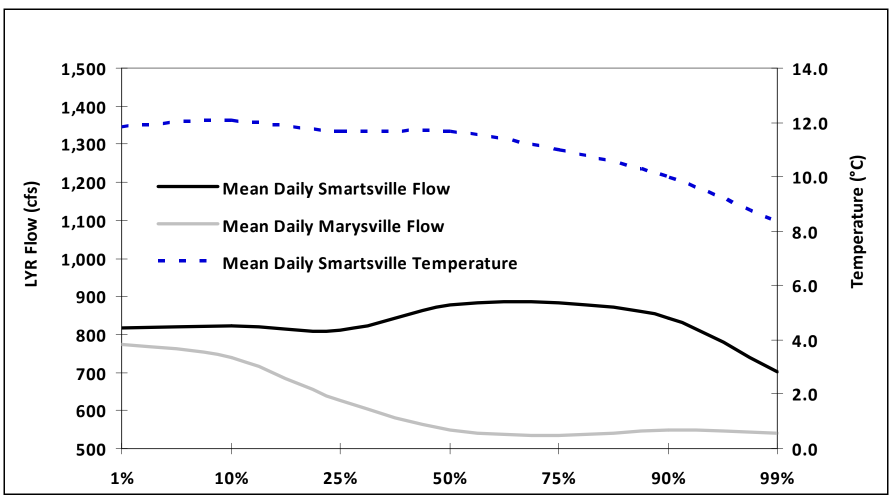

Figure 4. Mean daily flow (cfs) at the USGS Smartsville and Marysville gages and mean daily temperature (°C) at the USGS Smartsville gage through the percentile expressions (1%, 10%, 25%, 50%, 75%, 90% and 99%) for Chinook salmon redd abundance in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

[3] See discussion page 16.

A total of 241 steelhead trout[4] redds were observed during the 2009-2010 survey period in all surveyed reaches of the lower Yuba River. Peak observations of steelhead trout redds for the survey period occurred during the week of March 29, 2010 when 52 steelhead trout redds were observed (Figure 6, Appendix A, Table A2). The highest abundance of observed steelhead trout redds occurred in RM 19 (n=70), RM 20 (n=49) and RM 21(n=26); accounting for over 60% of the observed redds in the entire survey area (Appendix A, Tables A-25 through A-28).

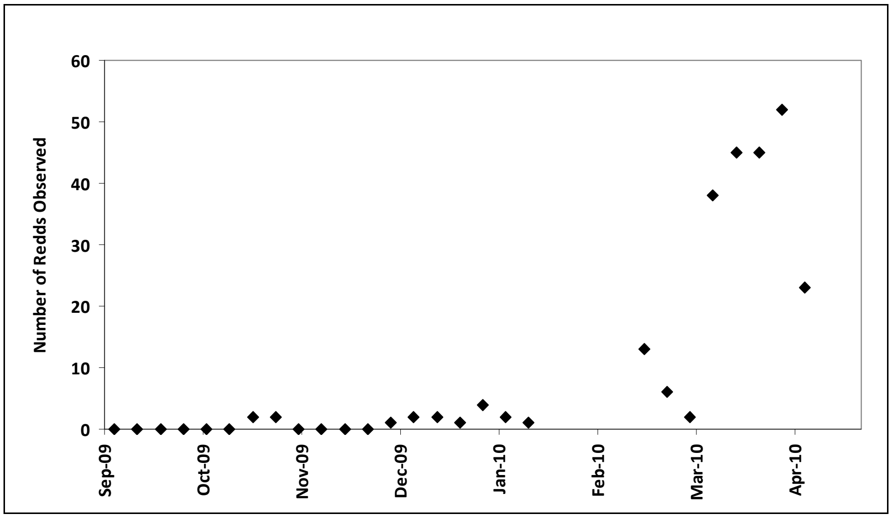

Figure 5. Weekly number of observed steelhead trout redds in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Spatial analysis of steelhead trout redd distributions using ArcGIS identified over 48% of redds occurring in riffle transition and slow glide morphological units. Redds constructed in riffle transitions represented 25.3% (n=61) of the observed redds, whereas redds constructed in slow glides constituted 22.8% (n=55) of the observed redds in all morphological units (Table 4). No steelhead trout redds were observed in bedrock, cutbank, floodplain, pond, tailings, terrace, tributary channel or tributary delta morphological units and were not included in Table 4. Nearly 89% of all observed steelhead trout redds occurred in the Timbuctoo Bend and Parks Bar reaches. Redds constructed in the Timbuctoo Bend reach represented 61.8% (n=149) of the observed total, whereas redds constructed in the Parks Bar Reach constituted 27% (n=65) of the cumulative total observed in all surveyed reaches (Table 4).

Table 4. Number of observed steelhead trout redds stratified by morphological unit in each of the eight reach delineations of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Morphological Unit	Englebright Dam Reach	Narrows Reach[1]	Timbutoo Bend Reach	Parks Bar Reach	Dry Creek Reach	Daguerre Dam Reach	Hallwood Reach	Marysville Reach	TOTALS	Percent
Chute	0	n/a	0	0	0	0	0	0	0	0.0%
Fast Glide	0	n/a	31	1	1	0	0	0	33	13.7%
Hillside	0	n/a	0	7	0	0	1	0	8	3.3%
Lateral Bar	0	n/a	0	0	0	5	0	0	5	2.1%
Medial Bar	0	n/a	0	0	0	0	0	0	0	0.0%
Point Bar	0	n/a	3	0	0	0	0	0	3	1.2%
Pool	0	n/a	0	0	0	0	0	0	0	0.0%
Riffle	0	n/a	17	12	0	6	0	0	35	14.5%
Riffle Transition	0	n/a	35	24	0	0	2	0	61	25.3%
Run	0	n/a	9	6	0	0	0	0	15	6.2%
Slackwater	0	n/a	8	7	2	0	2	0	19	7.9%
Slow Glide	0	n/a	46	6	1	0	2	0	55	22.8%
Swale	0	n/a	0	2	0	0	0	0	2	0.8%
No MU ID	0	5	0	0	0	0	0	0	5	2.1%
TOTALS	0	5	149	65	4	11	7	0	241	100.0%
Percent	0.0%	2.1%	61.8%	27.0%	1.7%	4.6%	2.9%	0.0%	100.0%	

[1] No morphological unit delineation yet exists for the Narrows Reach.

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

A total of 223 steelhead trout redds representing 92.5% of all observations were recorded upstream of DPD and 18 (7.5%) steelhead trout redds were observed downstream of DPD during the survey period. The peak observation of steelhead trout redds upstream of DPD occurred during the week of March 29, 2010 when 51 steelhead trout redds were observed, whereas peak observations downstream of DPD occurred during the week of March 8, 2010 when 4 steelhead trout redds were observed (Appendix A, Table A2).

A fitted asymmetric logistic function predicted that 50% of the steelhead trout redds were observed during the week of March 22, 2010, with 90% during the week of March 29, 2010 (Figure 7). The predicted date associated with the percentile expressions for steelhead trout were plotted against mean daily flow and water temperatures for each corresponding stratum and illustrated flow in a state of flux and temperature increasing throughout the percentile expressions (Figure 8).

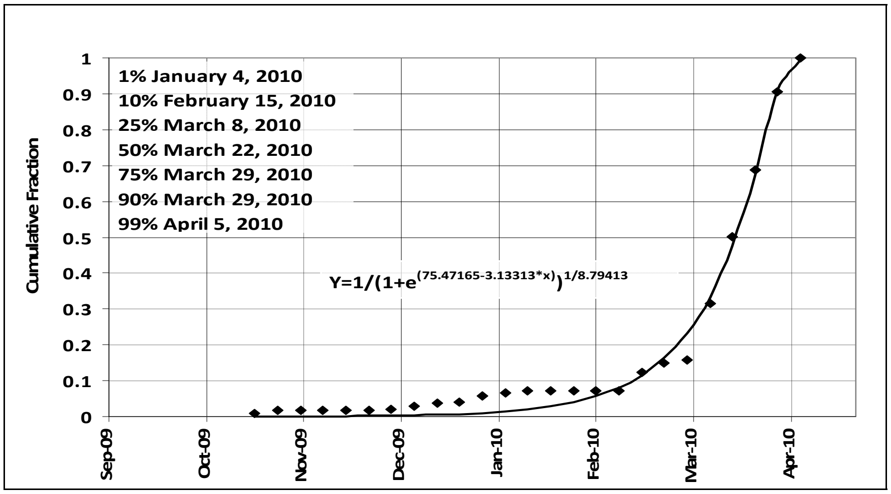

Figure 6. Cumulative temporal distribution of observed steelhead trout redd abundance in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

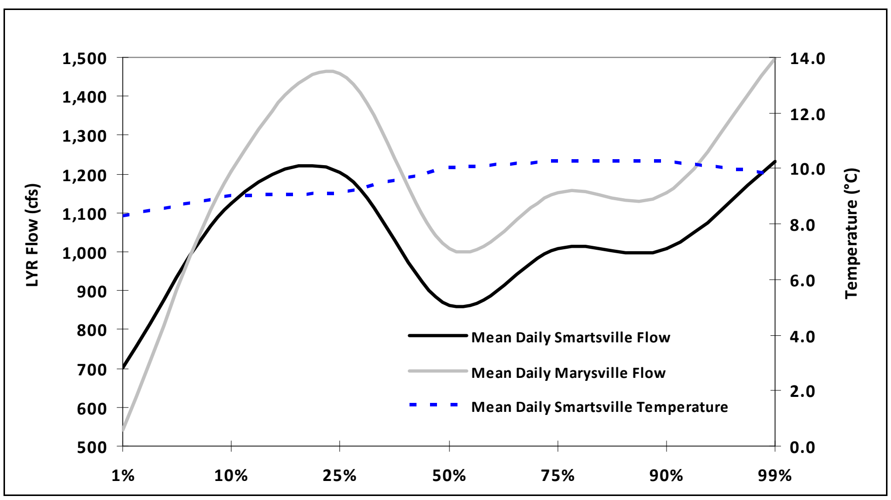

Figure 7. Mean daily flow (cfs) at the USGS Smartsville and Marysville gages and mean daily temperature (°C) at the USGS Smartsville gage through the percentile expressions 1%, 10%, 25%, 50%, 75%, 90% and 99% from observed steelhead trout redd abundance in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

4.3. Diversity

Chinook salmon redd measurements indicated that the mean pot length was 1.7m ± 0.06m (95% CI) and the mean pot width was 1.7m ± 0.09m (95% CI). The mean tail spill length was 2.8m ± 0.11m (95% CI), the mean tail spill width #1 was 1.9m ± 0.08m (95% CI) and the mean tail spill width #2 was 1.6m ± 0.07m (95% CI) (Table 5).

Table 5. Descriptive statistics for the physical size measurements (m) of systematically sampled Chinook salmon redds in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

	Pot Length	Pot Width	Tail Spill Length	Tail Spill Width #1	Tail Spill Width #2
Sample Size	251	251	251	251	251
MIN	0.6	0.5	1.1	0.4	0.5
MAX	3.2	4.2	5.2	4.0	3.4
MEAN	1.7	1.7	2.8	1.9	1.6
MEDIAN	1.6	1.6	2.8	1.8	1.6
VARIANCE	0.3	0.5	0.8	0.4	0.4
STD DEV	0.5	0.7	0.9	0.7	0.6
CONFIDENCE	0.06	0.09	0.11	0.08	0.07

Substrate characterizations for Chinook salmon redds identified that gravel was the dominant substrate class and fine cobble was the subdominant substrate class for 38% (n=1,268) of 3,332 observed redds (Table 6). The dominant and subdominant class observations for gravel and fine cobble were inverted for another 29% (n=956) of the total observed redds. The combined observations for gravel and fine cobble represented nearly 67% (n=2,224) of the substrate characterizations for Chinook salmon redds during the survey period.

Table 6. Number and frequency of each observed substrate characterization (dominant, subdominant) for Chinook salmon redds encountered in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Substrate Classification[1]	Number of Redds	Percent
Gravel , Fine Cobble	1268	38.06
Fine Cobble, Gravel	956	28.69
Fine Cobble, Coarse Cobble	554	16.63
Coarse Cobble, Fine Cobble	162	4.86
Gravel, Coarse Cobble	140	4.20
Coarse Cobble, Gravel	111	3.33
Coarse Cobble, Boulder	36	1.08
Gravel, Sand	33	0.99
Gravel, Boulder	15	0.45
Sand, Gravel	14	0.42
Fine Cobble, Fine Cobble	11	0.33
Fine Cobble, Boulder	9	0.27
Sand, Fine Cobble	6	0.18
Fine Cobble, Sand	4	0.12
Boulder, Fine Cobble	3	0.09
Boulder, Gravel	3	0.09
Sand, Coarse Cobble	2	0.06
Gravel, Gravel	2	0.06
Gravel, Silt/Clay	2	0.06
Coarse Cobble, Sand	1	0.03
TOTALS	3332	100.00

[1]Silt/Clay <0.0625 mm, Sand 0.0625-2 mm, Gravel 2-64 mm, Fine Cobble 64-128 mm, Coarse Cobble 128-256 mm, Boulder >256 mm.

Steelhead trout redd measurements indicated that the mean pot length was 0.6m ± 0.02m (95% CI) and the mean pot width was 0.6m ± 0.03m (95% CI). The mean tail spill length was 1.0m ± 0.05m (95% CI), the mean of tail spill width #1 was 0.6m ± 0.02m (95% CI) and the mean of tail spill width #2 was 0.5m ±

0.02m (95% CI). The mean redd depth for steelhead trout was 0.6m ± 0.03m (95% CI). The mean nose velocity was 0.52m/sec ± 0.03m/sec (95% CI) and the mean water column velocity was 0.56m/sec ± 0.03m/sec (95% CI) (Table 7).

Substrate characterizations for steelhead trout redds identified that fine cobble and gravel comprised the majority of observations. Substrate observations for fine cobble were represented by 42.76% ± 2.51% (95% CI), whereas gravel represented 38.67% ± 2.81% (95% CI) (Table 8) of the characterizations for steelhead trout redds.

Table 7. Descriptive statistics for the physical size measurements (m) and microhabitat features of sampled steelhead trout redds in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

	Pot Length	Pot Width	Tail Spill Length	Tail Spill Width #1	Tail Spill Width #2	Depth	Nose Velocity (m/sec)	Mean Velocity (m/sec)
Sample Size	227	227	227	227	227	203	201	201
MIN	0.2	0.2	0.2	0.1	0.1	0.1	0.01	0.01
MAX	1.4	1.7	2.4	1.3	1.1	1.3	1.19	1.10
MEAN	0.6	0.6	1.0	0.6	0.5	0.6	0.52	0.56
MEDIAN	0.6	0.6	1.0	0.6	0.5	0.6	0.49	0.53
VARIANCE	0.0	0.0	0.1	0.0	0.0	0.1	0.04	0.04
STD DEV	0.2	0.2	0.4	0.2	0.2	0.3	0.19	0.19
CONFIDENCE	0.02	0.03	0.05	0.02	0.02	0.03	0.03	0.03

Table 8. Descriptive Statistics for the substrate characterization percentages of sampled steelhead trout redds in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

	Bedrock	Boulder >256mm	Lg. Cobble 128-256 mm	Cobble 90-128 mm	Fine Cobble 32-90 mm	Gravel 2-32 mm	Sand 0.0625-2 mm	Silt/Clay <0.0625 mm
Sample Size	203	203	203	203	203	203	203	203
MIN	0%	0%	0%	0%	0%	0%	0%	0%
MAX	0%	70%	30%	50%	90%	100%	20%	10%
MEAN	0.00%	0.44%	2.41%	13.35%	42.76%	38.67%	1.82%	0.05%
MEDIAN	0%	0%	0%	10%	40%	30%	0%	0%
VARIANCE	0%	0.25%	0.36%	1.56%	3.32%	4.19%	0.24%	0.00%
STD DEV	0%	5.00%	6.02%	12.49%	18.22%	20.46%	4.89%	0.70%
CONFIDENCE	0%	0.69%	0.83%	1.72%	2.51%	2.81%	0.67%	0.10%

5. DISCUSSION

The number of salmonid redds reported in this annual report should be considered a minimum observation, since surveys could not be completed during the entire spawning period. Chinook salmon redd surveys were suspended on October 19, 2009 due to an early storm event. Observations from the following weekly survey strata resulted in redd counts that were likely a product of two consecutive weeks of spawning activity during the latter week's surveys. This limitation is especially evident during the expected steelhead trout spawning period (i.e. January-April, and to a lesser extent in May and June) (McEwan 2001). This temporal period normally corresponds with winter storms and surface run off which can lead to extended periods when surveys cannot be completed due to high flows, suspended sediments and high turbidity levels in the water. The difficulties of surveying steelhead trout have been discussed at length in the available literature largely due to their presence during winter months in riverine systems (McEwan 2001). During the 2009-2010 survey period, surveys were not completed from January 18, 2010 to February 8, 2010 as a result of high turbidity levels, likely leading to missed observations of steelhead trout redds reported for this annual study. These limitations were also observed during Vaki Riverwatcher monitoring at DPD on the lower Yuba River, as positive identification of steelhead trout passage has been difficult during periods of high turbidity (Massa *et. al.* 2010).

Additionally, all areas (e.g. depths) of the lower Yuba River were not observable using current survey methods. Non-wadeable areas in excess of two meters in depth on the lower Yuba River were excluded during weekly surveys, since river conditions normally only allow for visibility down to this depth. Anecdotal observations by surveyors suggest some deep water Chinook salmon redds were present in non-wadeable areas (e.g. water depths in excess of two meters), but no attempt was made to enumerate these redds for this annual report. New protocols and procedures are being developed by the lower Yuba River Accord RMT to address this data limitation, and plans for a specific Deep Water Redd Survey using vessel-mounted underwater videography are forthcoming. Furthermore, salmonid redd count data are subject to a host of unquantifiable sources of error, including variation in redd size, redd age, redd density, superimposition, water depth, water clarity, angle of incidence, fluvial hydraulics, and substrate composition. Current redd protocols at best provide for an index of relative spawner abundance, trend indicators and spawner distribution information (Kucera and Faurot 2004).

A proposed analytic of the M&E Plan was to identify and estimate the annual redd abundances for each of three runs of Chinook salmon known to occur in the lower Yuba River (spring-, fall- and late fall-run). An examination of the temporal distributions during the 2009-2010 survey period did not provide a clear distinction between all runs, thus run-specific estimates of redd abundance were not possible for this annual data report. The spatial and temporal periodicities of adult spawning overlap considerably in the lower Yuba River (Massa et al. 2009), as well as other Central Valley streams (Moyle 2002). The spawning periods for spring- and fall-run Chinook salmon historically overlapped in late summer and early fall (Yoshiyama *et. al.* 1996). Genetic integrity was maintained by differences in spawning locations; fall-run spawned near the valley floor, whereas spring-run migrated into upper reaches and tributaries (Yoshiyama *et. al.* 1996). To potentially address this limitation, genetic tissue samples were collected during annual escapement surveys 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. An analysis of otolith micro-chemical and micro-structural markers may also provide an increased understanding of the relative contribution of each run of Chinook salmon within the total population of adult spawners in the lower Yuba River. Otolith markers will be analyzed by Rachel Barnett-Johnson, PhD, as part of a cooperative joint project with the lower Yuba River Accord RMT.

The majority of fresh Chinook salmon redds were observed upstream of DPD in 2009-2010 (74%). During the 2009 lower Yuba River escapement survey, 85% of the carcasses were also observed upstream of DPD (Massa et. al. 2010). Past escapement surveys have also found that the majority of Chinook salmon spawning in the Lower Yuba River was observed upstream of DPD (Massa 2006, 2007, 2008; Massa et. al. 2009; Jones and Stokes 2006). Additionally, the highest abundance of steelhead trout redds was observed upstream of SR20 from RM 19 upstream to RM 21. Approximately 62% of all steelhead trout redds were observed in the Timbuctoo Bend reach and 93% were observed upstream of DPD. These observations continue to provide significant support for future restoration actions on the Yuba River for spawning and rearing areas located upstream of SR20 and DPD; and specifically for the proposed site rehabilitation at Sinoro Bar. Chinook salmon have heavily utilized spawning habitat upstream of SR20, as 34% of all fresh redds and 49.4% of all fresh carcasses were observed during the 2009-2010 escapement survey in the Timbuctoo Bend Reach from the Narrows pool to SR20 (Table 2). Areas upstream of the Deer Creek confluence have been identified as having suitable holding habitat, but devoid of spawning habitat for spring-run Chinook salmon (Pasternack 2009). During the 2009-2010 redd surveys, only 3% of the observed Chinook salmon redds occurred in habitats upstream of the Narrows Pool (Table 2). Additionally, the natural geomorphic processes essential to providing high quality spawning habitats have been largely impaired through the construction of Englebright Dam (CDWR 2009). 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 (Pasternack 2009). 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.

M&E Plan analytics pertaining to flow and temperature were completed, but the results were not included in this report. Multivariate analyses associated with single year observations (e.g. small sample size) can lead to spurious correlations (Gordon 1968). Additional long-term data are required to examine seasonal behaviors that may or may not be cyclic in nature. Although single season observations during the sample period did not indicate any significant correlation between adult Chinook salmon and steelhead trout spawning timing and the independent variants, a more comprehensive evaluation using both single and multivariate analysis utilizing time series data from multiple annual efforts will provide a more robust analysis. This approach is less likely to result in incorrect assertions and will provide a better understanding of the overall effects of Accord prescribed flows on fisheries resources in the lower Yuba River. This data report synthesizes the results from the first full year of extensive redd monitoring on the lower Yuba River and subsequent years of this effort will provide a basis for more comprehensive analyses.

Simple linear regression was utilized to examine the weekly frequency of superimposition by Chinook salmon on existing redds over the entire spawning season. A weak correlation between the temporal frequencies of superimposition was observed through the entire study period (Figure 3), where 45 percent of the observations were described. However, after removing all Chinook redd observations that occurred following the week of December 28, 2009 (n=76), the resulting regression described 76 percent of the previous strata's cumulative observations. An analysis of redd superimposition using data from this effort illuminated some additional considerations on how superimposition data are interpreted. Although superimposition does occur in the lower Yuba River, the temporal separation between early redd construction and subsequent superimposition by redds constructed later in the year can result in potentially misleading causal effects. Juvenile Chinook salmon emerge from gravel interstices in approximately 93 days at 10° C post-spawning (Jensen and Jensen 1999). Following emergence, redd superimposition likely has little effect on juvenile Chinook salmon. In short, the juvenile fish have already "left the nest" and subsequent superimposition activity on an existing redd would only serve to disrupt a previously vacated incubation area. An example, a redd that was first observed in early September and then later identified via GIS analysis as being superimposed by a redd constructed in January of the following year likely has no ecologically deleterious effects on inhabitants of the previously constructed redd. By focusing superimposition analyses on all observed redds regardless of the date of construction, a possibility exists that the effects of superimposition have been overrepresented, especially for redds that were superimposed at a more protracted date from original construction. The superimposition analysis completed in this report may represent a precise exercise in cataloging the level of superimposition in the lower Yuba River, but the inclusion of all results, regardless of date, may have also lead to an inflated frequency and magnitude of the actual effects to incubating eggs or pre-emergent juveniles in the lower Yuba River for this reporting period.

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8. APPENDIX A

Table A1. Weekly survey results for the Annual Redd Survey on the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Week	Survey	Mean Secchi	Smartsville Flow (cfs)			Marysville Flow (cfs)			Smartsville Temperature (°C)		
	Days	Depth (m)	Min	Max.	Mean	Min	Max.	Mean	Min	Max.	Mean
8/31/2009	3	4.0	855	1,082	913	801	1,006	870	11.39	11.59	11.48
9/7/2009	3	3.9	801	822	816	750	813	775	11.50	11.96	11.81
9/14/2009	5	4.1	819	820	820	747	800	764	11.95	12.12	12.04
9/21/2009	6	4.0	820	824	822	730	753	738	12.01	12.15	12.07
9/28/2009	5	3.7	767	819	798	602	701	647	11.69	12.06	11.88
10/5/2009	6	4.0	775	828	811	595	667	627	11.58	11.73	11.64
10/12/2009[1]	1	NO DATA	822	873	844	531	789	620	11.56	11.93	11.75
10/19/2009	6	3.3	870	880	878	541	568	549	11.51	11.83	11.68
10/26/2009	6	3.5	824	858	839	532	561	542	10.99	11.45	11.16
11/2/2009	6	3.5	855	892	883	529	545	536	10.83	11.04	10.98
11/9/2009	6	3.3	874	894	882	529	547	534	10.51	10.78	10.64
11/16/2009	5	3.5	874	882	879	525	558	536	10.12	10.50	10.31
11/23/2009	4	2.8	816	869	844	535	558	548	9.83	10.05	9.95
11/30/2009	5	2.7	786	818	804	526	551	538	9.23	9.64	9.49
12/7/2009	5	2.0	737	800	784	535	782	598	8.66	9.11	8.79
12/14/2009	5	2.3	720	774	746	571	740	629	8.52	8.69	8.60
12/21/2009	4	2.4	715	720	718	560	575	566	8.41	8.67	8.51
12/28/2009	4	3.0	703	714	707	542	560	552	8.28	8.42	8.33
1/4/2010	3	2.3	702	704	703	535	545	541	8.25	8.32	8.29
1/11/2010	5	1.8	705	711	708	535	707	630	8.35	8.79	8.57
1/18/2010	NO SURVEYS		798	2,834	1,937	1,179	4,430	2,741	8.30	8.71	8.46
1/25/2010			970	974	972	1,104	1,507	1,246	8.23	8.35	8.28
2/1/2010			1,041	1,132	1,118	1,098	1,315	1,238	8.25	8.47	8.37
2/8/2010			1,126	1,136	1,132	1,220	1,332	1,269	8.57	8.82	8.67
2/15/2010	4	2.0	1,123	1,126	1,124	1,202	1,216	1,207	8.87	9.16	9.01
2/22/2010	4	2.1	1,127	1,244	1,148	1,203	1,790	1,420	8.89	9.26	9.06
3/1/2010[1]	1	2.5	1,191	2,311	1,686	1,468	2,705	2,007	8.97	9.34	9.12
3/8/2010	5	2.1	1,186	1,210	1,205	1,399	1,655	1,458	8.79	9.30	9.11
3/15/2010	5	2.6	977	1,207	1,125	1,125	1,437	1,314	9.16	9.64	9.40
3/22/2010	5	3.0	829	977	861	956	1,100	1,007	9.68	10.30	10.02
3/29/2010	4	3.0	836	1,181	1,007	974	1,378	1,151	10.04	10.43	10.25
4/5/2010	3	2.3	1,183	1,258	1,233	1,428	1,634	1,496	9.59	10.05	9.80

[1] Incomplete survey week and incomplete reaches.

Table A2. Weekly observed Chinook salmon and steelhead trout redd abundance in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Week	Below DPD		20 to DPD		Above 20		All Reaches	
	Chinook	Steelhead	Chinook	Steelhead	Chinook	Steelhead	Chinook	Steelhead
8/31/2009	0	0	0	0	0	0	0	0
9/7/2009	0	0	0	0	7	0	7	0
9/14/2009	1	0	13	0	88	0	102	0
9/21/2009	5	0	65	0	180	0	250	0
9/28/2009	16	0	94	0	244	0	354	0
10/5/2009	35	0	165	0	315	0	515	0
10/12/2009[1]	NO SURVEY		NO SURVEY		20	0	20	0
10/19/2009	110	0	281	0	182	2	573	2
10/26/2009	152	1	207	1	146	0	505	2
11/2/2009	146	0	123	0	56	0	325	0
11/9/2009	85	0	80	0	25	0	190	0
11/16/2009	87	0	39	0	9	0	135	0
11/23/2009	101	0	26	0	8	0	135	0
11/30/2009	40	0	11	0	12	1	63	1
12/7/2009	33	2	9	0	10	0	52	2
12/14/2009	18	1	7	1	7	0	32	2
12/21/2009	4	1	4	0	7	0	15	1
12/28/2009	5	0	5	1	2	3	12	4
1/4/2010	3	0	3	0	6	2	12	2
1/11/2010	1	1	4	0	1	0	6	1
1/18/2010 1/25/2010 2/1/2010 2/8/2010	NO SURVEY		NO SURVEY		NO SURVEY		NO SURVEY	
2/15/2010	5	1	4	3	6	9	15	13
2/22/2010	6	1	2	3	3	2	11	6
3/1/2010[2]	NO SURVEY		1	0	3	2	4	2
3/8/2010	6	4	4	13	0	21	10	38
3/15/2010	4	3	3	10	8	32	15	45
3/22/2010	2	2	0	13	0	30	2	45
3/29/2010	0	1	0	14	0	37	0	52
4/5/2010	1	0	0	10	0	13	1	23
TOTALS	866	18	1,150	69	1,345	154	3,361	241

Table A3. Weekly observed Chinook salmon redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of August 31, 2009 to the week of October 19, 2009.

River Mile	8/31/2009	9/7/2009	9/14/2009	9/21/2009	9/28/2009	10/5/2009	10/12/2009[1]	10/19/2009
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	2
6	0	0	0	0	0	1	0	8
7	0	0	0	0	0	0	0	5
8	0	0	0	0	0	0	0	10
9	0	0	0	0	1	8	0	41
10	0	0	0	0	0	0	0	14
11	0	0	1	5	15	29	0	35
12	0	0	0	0	1	5	0	18
13	0	0	2	5	4	11	0	16
14	0	0	3	3	7	20	0	57
15	0	0	1	25	36	64	0	94
16	0	0	2	7	17	16	0	43
17	0	0	5	25	29	46	0	24
18	0	2	13	22	31	30	0	39
19	0	2	15	28	46	55	0	42
20	0	0	21	30	63	63	0	34
21	0	3	37	92	94	145	0	61
22	0	0	0	0	1	1	0	0
23	0	0	2	8	9	20	20	23
24	0	0	0	0	0	1	0	0
TOTALS	0	7	102	250	354	515	20	566

[1] Incomplete survey week and incomplete reaches.

Table A4. Weekly observed Chinook salmon redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of October 26, 2009 to the week of December 14, 2009.

River Mile	10/26/2009	11/2/2009	11/9/2009	11/16/2009	11/23/2009	11/30/2009	12/7/2009	12/14/2009
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	1	0	1	0	0	0	0	0
3	4	3	7	0	12	4	0	0
4	8	11	4	2	2	1	0	0
5	10	13	5	1	7	1	0	1
6	12	20	10	10	11	2	0	1
7	10	18	8	12	15	13	6	5
8	6	9	5	8	8	5	3	2
9	51	39	23	20	18	10	6	0
10	17	13	8	8	7	3	8	3
11	35	20	21	26	21	1	10	6
12	16	13	8	5	1	0	2	2
13	14	7	6	4	0	0	0	2
14	26	13	17	3	5	5	2	0
15	73	45	27	12	10	3	1	1
16	35	17	9	8	8	3	1	1
17	26	20	6	5	2	0	3	1
18	33	15	1	3	2	2	0	0
19	53	17	7	1	2	2	1	1
20	34	20	6	4	2	4	6	3
21	33	12	10	3	2	4	2	3
22	0	0	0	0	0	0	0	0
23	8	0	1	0	0	0	1	0
24	0	0	0	0	0	0	0	0
TOTALS	505	325	190	135	135	63	52	32

Table A5. Weekly observed Chinook salmon redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of December 21, 2009 to the week of February 8, 2010.

River Mile	12/21/2009	12/28/2009	1/4/2010	1/11/2010	1/18/2010	1/25/2010	2/1/2010	2/8/2010
0	0	0	0	0				
1	0	0	0	0				
2	0	0	0	0				
3	0	0	0	0				
4	0	0	0	0				
5	0	0	0	0				
6	0	1	0	0				
7	1	0	1	0				
8	1	0	0	0				
9	0	2	2	0				
10	0	0	0	0				
11	2	2	0	1				
12	0	0	0	0	NO SURVEY	NO SURVEY	NO SURVEY	NO SURVEY
13	0	0	0	1				
14	1	3	0	0				
15	2	2	1	0				
16	0	0	0	2				
17	0	0	2	1				
18	2	0	2	0				
19	0	2	3	0				
20	4	0	0	0				
21	2	0	0	0				
22	0	0	0	0				
23	0	0	1	0				
24	0	0	0	1				
TOTALS	15	12	12	6	N/A	N/A	N/A	N/A

Table A6. Weekly observed Chinook salmon redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of February 15, 2010 to the week of April 5, 2010.

River Mile	2/15/2010	2/22/2010	3/1/2010[1]	3/8/2010	3/15/2010	3/22/2010	3/29/2010	4/5/2010	All Weeks
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2
3	0	0	0	0	0	0	0	0	30
4	0	0	0	0	0	0	0	0	28
5	0	0	0	0	0	0	0	0	40
6	0	0	0	0	0	0	0	0	76
7	0	0	0	2	0	0	0	0	96
8	0	0	0	0	0	0	0	0	57
9	0	0	0	1	1	1	0	0	224
10	3	2	0	0	0	0	0	0	86
11	2	4	0	3	3	1	0	1	244
12	1	0	0	0	0	0	0	0	72
13	0	0	1	0	0	0	0	0	73
14	0	0	0	0	0	0	0	0	165
15	3	0	0	1	0	0	0	0	401
16	1	0	0	0	0	0	0	0	170
17	0	1	0	1	0	0	0	0	197
18	3	1	1	2	3	0	0	0	207
19	1	0	0	0	0	0	0	0	278
20	0	0	0	0	3	0	0	0	297
21	0	1	2	0	5	0	0	0	511
22	0	0	0	0	0	0	0	0	2
23	1	2	0	0	0	0	0	0	96
24	0	0	0	0	0	0	0	0	2
TOTALS	15	11	4	10	15	2	0	1	3354

[1] Incomplete survey week and incomplete reaches.

Table A7. Simple linear regression analysis results to assess the number and location by river mile of new redds built during each weekly stratum and over the entire spawning season in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Week	Number of Redds in Analysis	R^2	Significance F	Coefficients		P Values	
				Y	X	Y	X
8/31/2009	0	NO REDDS OBSERVED					
9/7/2009	7	0.144	0.062	-0.2092	0.0408	0.479	0.062
9/14/2009	102	0.235	0.014	-2.8338	0.5762	0.360	0.014
9/21/2009	250	0.238	0.013	-5.8585	1.3215	0.405	0.013
9/28/2009	354	0.295	0.005	-6.9600	1.7600	0.390	0.005
10/5/2009	515	0.276	0.007	-7.9600	2.3800	0.486	0.007
10/12/2009	20	INCOMPLETE SURVEY					
10/19/2009[1]	566	0.214	0.020	4.2431	1.5331	0.625	0.020
10/26/2009	505	0.131	0.076	8.8185	0.9485	0.229	0.076
11/2/2009	325	0.010	0.641	11.1723	0.1523	0.021	0.641
11/9/2009	190	0.000	0.927	7.3692	0.0192	0.019	0.927
11/16/2009	135	0.006	0.713	6.2308	-0.0692	0.025	0.713
11/23/2009	135	0.073	0.191	8.1046	-0.2254	0.002	0.191
11/30/2009	63	0.011	0.617	3.0738	-0.0462	0.024	0.617
12/7/2009	52	0.002	0.822	1.8585	0.0185	0.116	0.822
12/14/2009	32	0.002	0.819	1.1508	0.0108	0.091	0.819
12/21/2009	15	0.103	0.118	0.0554	0.0454	0.889	0.118
12/28/2009	12	0.005	0.725	0.3692	0.0092	0.320	0.725
1/4/2010	12	0.089	0.147	0.0554	0.0354	0.868	0.147
1/11/2010	6	0.073	0.191	0.0092	0.0192	0.964	0.191
1/18/2010	NO SURVEY						
1/25/2010							
2/1/2010							
2/8/2010							
2/15/2010	15	0.050	0.284	0.2215	0.0315	0.587	0.284
2/22/2010	11	0.040	0.337	0.1262	0.0262	0.739	0.337
3/1/2010	4	INCOMPLETE SURVEY					
3/8/2010	10	0.001	0.895	0.3631	0.0031	0.274	0.895
3/15/2010	15	0.115	0.098	-0.1477	0.0623	0.773	0.098
3/22/2010	2	0.007	0.698	0.1169	-0.0031	0.297	0.698
3/29/2010	0	NO REDDS OBSERVED					
4/5/2010	1	0.001	0.893	0.0492	-0.0008	0.541	0.893
ALL WEEKS	3354	0.234	0.014	28.1169	8.8369	0.553	0.014

[1] Seven of the 573 observed redds had no positional data due to poor satellite coverage

Table A8. Weekly Chinook salmon redd superimposition frequency in the surveyed reaches of the lower Yuba River, CA from August 31, 2009 to April 8, 2010.

Week	Number of New Redds in Analysis	Number Superimposed on Previous Redds	Superimposition Frequency (%)
8/31/2009	0	0	0
9/7/2009	7	0	0
9/14/2009	101	18	17.8
9/21/2009	250	94	37.6
9/28/2009	354	152	42.9
10/5/2009	514	283	55.1
10/12/2009[1]	20	13	65.0
10/19/2009	566[2]	239	42.2
10/26/2009	505	307	60.8
11/2/2009	325	179	55.1
11/9/2009	190	111	58.4
11/16/2009	135	76	56.3
11/23/2009	135	89	65.9
11/30/2009	63	51	81.0
12/7/2009	52	38	73.1
12/14/2009	32	23	71.9
12/21/2009	15	12	80.0
12/28/2009	12	7	58.3
1/4/2010	12	8	66.7
1/11/2010	6	3	50.0
1/18/2010		NO SURVEY	
1/25/2010			
2/1/2010			
2/8/2010			
2/15/2010	15	6	40.0
2/22/2010	11	8	72.7
3/1/2010[3]	4	2	50.0
3/8/2010	10	4	40.0
3/15/2010	15	10	66.7
3/22/2010	2	2	100.0
3/29/2010	0	0	N/A
4/5/2010	1	1	100.0

[1,3] Incomplete survey week and incomplete reaches

[2] Seven of the 573 observed redds had no positional data due to poor satellite coverage

Table A9. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of August 31, 2009 to the week of September 21, 2009.

Percentage of	8/31/2009		9/7/2009		9/14/2009		9/21/2009	
Redd Overlap	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	0	0	0	0	0	4	28	20
5-10%	0	0	0	0	4	4	7	20
10-15%	0	0	0	0	0	0	7	14
15-20%	0	0	0	0	0	0	3	10
20-25%	0	0	0	0	4	4	3	10
25-30%	0	0	0	0	2	2	4	10
30-35%	0	0	0	0	0	0	1	8
35-40%	0	0	0	0	2	4	0	10
40-45%	0	0	0	0	0	0	1	11
45-50%	0	0	0	0	0	2	0	11
50-55%	0	0	0	0	0	2	0	6
55-60%	0	0	0	0	0	0	0	2
60-65%	0	0	0	0	0	0	0	8
65-70%	0	0	0	0	0	0	0	0
70-75%	0	0	0	0	0	2	0	9
75-80%	0	0	0	0	0	0	0	2
80-85%	0	0	0	0	0	0	0	6
85-90%	0	0	0	0	0	0	0	3
90-95%	0	0	0	0	0	0	0	0
95-100%	0	0	0	0	0	0	0	1
TOTALS	0	0	0	0	12	24	54	161

Table A10. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of September 28, 2009 to the week of October 19, 2009.

Percentage of	9/28/2009		10/5/2009		10/12/2009[1]		10/19/2009	
Redd Overlap	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	12	34	43	71	0	68	24	98
5-10%	5	32	9	58	0	56	8	84
10-15%	3	37	12	61	0	62	4	81
15-20%	6	21	6	39	0	41	2	53
20-25%	3	31	4	40	0	40	0	60
25-30%	1	32	3	43	0	44	2	62
30-35%	1	20	2	37	0	35	0	48
35-40%	2	25	1	43	0	42	2	54
40-45%	0	24	0	51	4	53	0	65
45-50%	0	22	1	53	0	54	2	61
50-55%	0	21	1	41	0	42	0	57
55-60%	0	10	0	51	0	52	0	74
60-65%	0	29	0	58	0	59	0	67
65-70%	0	11	0	27	0	29	0	52
70-75%	0	19	0	31	0	32	0	51
75-80%	0	4	0	27	0	32	0	57
80-85%	0	14	0	28	0	30	0	48
85-90%	0	9	0	21	0	24	0	33
90-95%	0	2	0	14	0	15	0	35
95-100%	0	8	0	20	0	20	0	39
TOTALS	33	405	82	814	4	830	44	1179

[1] Incomplete survey week and incomplete reaches.

Table A11. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of October 26, 2009 to the week of November 16, 2009.

Percentage of Redd Overlap	10/26/2009		11/2/2009		11/9/2009		11/16/2009	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	27	120	6	145	4	162	6	168
5-10%	8	124	4	130	6	147	2	153
10-15%	8	87	0	97	0	107	0	112
15-20%	2	81	0	90	0	96	0	96
20-25%	2	78	2	97	0	107	0	116
25-30%	0	80	0	107	0	104	0	107
30-35%	0	87	2	94	0	102	0	106
35-40%	0	82	0	91	0	91	0	93
40-45%	0	78	0	97	0	103	0	113
45-50%	2	78	0	94	0	98	0	106
50-55%	0	85	0	102	0	108	0	113
55-60%	0	101	0	112	0	118	0	124
60-65%	0	84	0	89	0	100	0	104
65-70%	0	79	0	83	0	87	0	94
70-75%	0	78	0	90	0	106	0	111
75-80%	0	85	0	94	0	97	0	102
80-85%	0	70	0	89	0	94	0	100
85-90%	0	53	0	66	0	80	0	88
90-95%	0	51	0	62	0	73	0	83
95-100%	0	60	0	73	0	87	0	93
TOTALS	49	1641	14	1902	10	2067	8	2182

Table A12. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of November 23, 2009 to the week of December 14, 2009.

Percentage of Redd Overlap	11/23/2009		11/30/2009		12/7/2009		12/14/2009	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	4	166	0	170	0	173	0	176
5-10%	2	152	0	149	0	147	0	149
10-15%	2	122	0	121	0	125	0	128
15-20%	0	98	0	97	0	101	0	102
20-25%	0	120	0	129	0	128	0	127
25-30%	0	113	0	118	2	118	0	117
30-35%	0	111	0	106	0	115	0	118
35-40%	0	100	0	104	0	108	0	108
40-45%	0	114	0	121	0	123	0	119
45-50%	0	119	0	120	0	115	0	122
50-55%	0	123	0	127	0	130	0	129
55-60%	0	126	0	131	0	137	0	140
60-65%	0	116	0	119	0	120	0	123
65-70%	0	93	0	98	0	100	0	106
70-75%	0	114	0	121	0	122	0	123
75-80%	0	110	0	113	0	115	0	117
80-85%	0	109	0	111	0	115	0	115
85-90%	0	91	0	98	0	100	0	102
90-95%	0	94	0	98	0	102	0	104
95-100%	0	108	0	117	0	126	0	128
TOTALS	8	2299	0	2368	2	2420	0	2453

Table A13. Chinook salmon redd superimposition magnitude within each stratum and including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of December 21, 2009 to the week of January 11, 2010.

Percentage of	12/21/2009		12/28/2009		1/4/2010		1/11/2010	
Redd Overlap	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	2	175	0	176	0	176	0	176
5-10%	0	149	0	149	0	146	0	146
10-15%	0	126	0	125	0	124	0	124
15-20%	0	103	0	103	0	103	0	104
20-25%	0	128	0	128	0	130	0	130
25-30%	0	119	0	119	0	119	0	119
30-35%	0	117	0	118	0	118	0	120
35-40%	0	108	0	109	0	110	0	110
40-45%	0	118	0	118	0	118	0	118
45-50%	0	124	0	122	0	123	0	122
50-55%	0	128	0	132	0	132	0	132
55-60%	0	141	0	142	0	142	0	142
60-65%	0	122	0	122	0	124	0	125
65-70%	0	108	0	109	0	109	0	109
70-75%	0	125	0	125	0	124	0	124
75-80%	0	119	0	120	0	122	0	121
80-85%	0	115	0	115	0	116	0	117
85-90%	0	106	0	106	0	109	0	107
90-95%	0	104	0	106	0	106	0	108
95-100%	0	134	0	134	0	136	0	137
TOTALS	2	2469	0	2478	0	2487	0	2491

Table A14. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of January 18, 2010 to the week of February 8, 2010.

Percentage of	1/18/2010		1/25/2010		2/1/2010		2/8/2010	
Redd Overlap	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	NO SURVEY	176	NO SURVEY	176	NO SURVEY	176	NO SURVEY	176
5-10%		146		146		146		146
10-15%		124		124		124		124
15-20%		104		104		104		104
20-25%		130		130		130		130
25-30%		119		119		119		119
30-35%		120		120		120		120
35-40%		110		110		110		110
40-45%		118		118		118		118
45-50%		122		122		122		122
50-55%		132		132		132		132
55-60%		142		142		142		142
60-65%		125		125		125		125
65-70%		109		109		109		109
70-75%		124		124		124		124
75-80%		121		121		121		121
80-85%		117		117		117		117
85-90%		107		107		107		107
90-95%		108		108		108		108
95-100%		137		137		137		137
TOTALS	N/A	2491	N/A	2491	N/A	2491	N/A	2491

Table A15. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of February 15, 2010 to the week of March 8, 2010.

Percentage of Redd Overlap	2/15/2010		2/22/2010		3/1/2010[1]		3/8/2010	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	0	177	0	176	0	176	0	177
5-10%	0	144	0	145	0	145	0	147
10-15%	0	124	0	124	0	124	0	123
15-20%	0	104	0	104	0	104	0	103
20-25%	0	131	0	132	0	132	0	133
25-30%	0	118	0	118	0	118	0	117
30-35%	0	119	0	119	0	119	0	119
35-40%	0	112	0	114	0	114	0	114
40-45%	0	119	0	119	0	119	0	119
45-50%	0	122	0	121	0	121	0	120
50-55%	0	132	0	133	0	133	0	134
55-60%	0	144	0	145	0	145	0	145
60-65%	0	127	0	127	0	126	0	126
65-70%	0	109	0	108	0	108	0	110
70-75%	0	123	0	125	0	124	0	124
75-80%	0	120	0	121	0	121	0	122
80-85%	0	121	0	121	0	120	0	121
85-90%	0	106	0	108	0	111	0	111
90-95%	0	109	0	110	0	111	0	111
95-100%	0	137	0	138	0	139	0	139
TOTALS	0	2498	0	2508	0	2510	0	2515

[1] Incomplete survey week and incomplete reaches.

Table A16. Chinook salmon redd superimposition magnitude within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of March 15, 2010 to the week of April 5, 2010.

Percentage of Redd Overlap	3/15/2010		3/22/2010		3/29/2010		4/5/2010	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0-5%	0	176	0	177	0	177	0	177
5-10%	0	150	0	149	0	149	0	149
10-15%	0	123	0	123	0	123	0	123
15-20%	0	103	0	103	0	103	0	103
20-25%	0	131	0	133	0	133	0	133
25-30%	0	117	0	117	0	117	0	117
30-35%	0	117	0	118	0	118	0	118
35-40%	0	115	0	115	0	115	0	117
40-45%	0	119	0	120	0	120	0	120
45-50%	0	123	0	123	0	123	0	123
50-55%	0	135	0	135	0	135	0	135
55-60%	0	144	0	144	0	144	0	144
60-65%	0	125	0	125	0	125	0	125
65-70%	0	111	0	111	0	111	0	111
70-75%	0	126	0	126	0	126	0	126
75-80%	0	121	0	121	0	121	0	121
80-85%	0	125	0	125	0	125	0	125
85-90%	0	110	0	110	0	110	0	110
90-95%	0	113	0	113	0	113	0	113
95-100%	0	142	0	142	0	142	0	142
TOTALS	0	2526	0	2530	0	2530	0	2532

Table A17. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of August 31, 2009 to the week of September 21, 2009.

River Mile	8/31/2009		9/7/2009		9/14/2009		9/21/2009	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	3
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	2
15	0	0	0	0	0	0	0	2
16	0	0	0	0	0	0	0	2
17	0	0	0	0	0	0	0	9
18	0	0	0	0	0	4	0	12
19	0	0	0	0	0	4	0	16
20	0	0	0	0	6	6	8	27
21	0	0	0	0	6	10	42	81
22	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	4	7
24	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	12	24	54	161

Table A18. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of September 28, 2009 to the week of October 19, 2009.

River Mile	9/28/2009		10/5/2009		10/12/2009[1]		10/19/2009	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	2
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	2	0	2	2	6
10	0	0	0	0	0	0	4	4
11	3	11	2	25	0	25	7	54
12	0	0	0	0	0	0	0	2
13	0	2	0	8	0	8	0	18
14	2	7	0	12	0	12	0	38
15	2	31	2	68	0	68	2	130
16	2	10	2	20	0	20	2	42
17	3	33	6	79	0	79	0	90
18	0	32	2	57	0	57	12	83
19	2	53	2	99	0	99	2	126
20	8	70	6	135	0	135	3	168
21	11	144	55	282	0	282	2	350
22	0	0	0	2	0	2	0	2
23	0	12	5	25	4	41	8	64
24	0	0	0	0	0	0	0	0
TOTALS	33	405	82	814	4	830	44	1179

[1] Incomplete survey week and incomplete reaches.

Table A19. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of October 26, 2009 to the week of November 16, 2009.

River Mile	10/26/2009		11/2/2009		11/9/2009		11/16/2009	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	2	2	0	2	0	2
4	0	0	2	2	0	2	0	2
5	2	4	2	8	0	13	0	13
6	2	5	2	18	0	22	0	28
7	0	3	2	13	0	21	2	29
8	0	5	0	5	0	11	0	19
9	6	50	2	73	0	84	0	107
10	2	18	0	22	0	30	2	37
11	4	81	0	92	2	113	2	134
12	0	14	0	29	2	37	0	40
13	2	28	0	31	2	37	0	38
14	0	67	0	78	0	95	0	99
15	8	214	0	271	4	301	0	314
16	4	75	0	99	0	104	2	113
17	2	118	0	136	0	144	0	146
18	2	119	0	131	0	131	0	133
19	6	177	2	196	0	204	0	205
20	9	205	0	226	0	234	0	238
21	0	384	0	396	0	407	0	410
22	0	2	0	2	0	2	0	2
23	0	72	0	72	0	73	0	73
24	0	0	0	0	0	0	0	0
TOTALS	49	1641	14	1902	10	2067	8	2182

Table A20. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of November 23, 2009 to the week of December 14, 2009.

River Mile	11/23/2009		11/30/2009		12/7/2009		12/14/2009	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	2	10	0	17	0	17	0	17
4	0	2	0	4	0	4	0	4
5	0	16	0	16	0	16	0	17
6	0	35	0	37	0	37	0	39
7	0	40	0	52	2	57	0	63
8	0	28	0	34	0	37	0	38
9	0	126	0	134	0	141	0	141
10	0	38	0	43	0	51	0	54
11	4	152	0	153	0	164	0	169
12	0	42	0	42	0	43	0	43
13	0	38	0	38	0	38	0	40
14	0	107	0	114	0	115	0	115
15	2	326	0	329	0	331	0	332
16	0	121	0	124	0	126	0	127
17	0	149	0	149	0	151	0	153
18	0	136	0	138	0	138	0	138
19	0	207	0	209	0	211	0	213
20	0	240	0	245	0	250	0	253
21	0	411	0	415	0	417	0	421
22	0	2	0	2	0	2	0	2
23	0	73	0	73	0	74	0	74
24	0	0	0	0	0	0	0	0
TOTALS	8	2299	0	2368	2	2420	0	2453

Table A21. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of December 21, 2009 to the week of January 11, 2010.

River Mile	12/21/2009		12/28/2009		1/4/2010		1/11/2010	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	17	0	17	0	17	0	17
4	0	4	0	4	0	4	0	4
5	0	17	0	17	0	17	0	17
6	0	39	0	39	0	39	0	39
7	0	65	0	65	0	65	0	65
8	0	38	0	38	0	38	0	38
9	0	141	0	141	0	142	0	142
10	0	54	0	54	0	54	0	54
11	0	171	0	171	0	171	0	172
12	0	43	0	43	0	43	0	43
13	0	40	0	40	0	40	0	40
14	0	115	0	118	0	118	0	118
15	0	334	0	336	0	337	0	337
16	0	127	0	127	0	127	0	129
17	0	153	0	153	0	154	0	155
18	0	140	0	140	0	141	0	141
19	0	213	0	217	0	220	0	220
20	2	259	0	259	0	259	0	259
21	0	423	0	423	0	423	0	423
22	0	2	0	2	0	2	0	2
23	0	74	0	74	0	76	0	76
24	0	0	0	0	0	0	0	0
TOTALS	2	2469	0	2478	0	2487	0	2491

Table A22. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of January 18, 2010 to the week of February 8, 2010.

River Mile	1/18/2010		1/25/2010		2/1/2010		2/8/2010	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0		0		0		0		0
1		0		0		0		0
2		0		0		0		0
3		17		17		17		17
4		4		4		4		4
5		17		17		17		17
6		39		39		39		39
7		65		65		65		65
8		38		38		38		38
9		142		142		142		142
10		54		54		54		54
11		172		172		172		172
12	NO SURVEY	43	NO SURVEY	43	NO SURVEY	43	NO SURVEY	43
13		40		40		40		40
14		118		118		118		118
15		337		337		337		337
16		129		129		129		129
17		155		155		155		155
18		141		141		141		141
19		220		220		220		220
20		259		259		259		259
21		423		423		423		423
22		2		2		2		2
23		76		76		76		76
24		0		0		0		0
TOTALS	N/A	2491	N/A	2491	N/A	2491	N/A	2491

Table A23. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of February 15, 2010 to the week of March 8, 2010.

River Mile	2/15/2010		2/22/2010		3/1/2010[1]		3/8/2010	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0
3	0	17	0	17	0	17	0	17
4	0	4	0	4	0	4	0	4
5	0	17	0	17	0	17	0	17
6	0	39	0	39	0	39	0	39
7	0	65	0	65	0	65	0	67
8	0	38	0	38	0	38	0	38
9	0	142	0	142	0	142	0	143
10	0	54	0	57	0	57	0	57
11	0	174	0	177	0	177	0	177
12	0	43	0	43	0	43	0	43
13	0	40	0	40	0	40	0	40
14	0	118	0	118	0	118	0	118
15	0	338	0	338	0	338	0	338
16	0	130	0	130	0	130	0	130
17	0	155	0	156	0	156	0	156
18	0	144	0	144	0	144	0	146
19	0	220	0	220	0	220	0	220
20	0	259	0	259	0	259	0	259
21	0	423	0	424	0	426	0	426
22	0	2	0	2	0	2	0	2
23	0	76	0	78	0	78	0	78
24	0	0	0	0	0	0	0	0
TOTALS	0	2498	0	2508	0	2510	0	2515

[1] Incomplete survey week and incomplete reaches.

Table A24. Chinook salmon redd superimposition frequency by river mile within each stratum including cumulative totals in the surveyed reaches of the lower Yuba River, CA from the week of March 15, 2010 to the week of April 5, 2010.

River Mile	3/15/2010		3/22/2010		3/29/2010		4/5/2010	
	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative	Within Stratum	Cumulative
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	17	0	17	0	17	0	17
4	0	4	0	4	0	4	0	4
5	0	17	0	17	0	17	0	17
6	0	39	0	39	0	39	0	39
7	0	67	0	67	0	67	0	67
8	0	38	0	38	0	38	0	38
9	0	144	0	146	0	146	0	146
10	0	57	0	57	0	57	0	57
11	0	179	0	181	0	181	0	183
12	0	43	0	43	0	43	0	43
13	0	40	0	40	0	40	0	40
14	0	118	0	118	0	118	0	118
15	0	338	0	338	0	338	0	338
16	0	130	0	130	0	130	0	130
17	0	156	0	156	0	156	0	156
18	0	146	0	146	0	146	0	146
19	0	220	0	220	0	220	0	220
20	0	262	0	262	0	262	0	262
21	0	431	0	431	0	431	0	431
22	0	2	0	2	0	2	0	2
23	0	78	0	78	0	78	0	78
24	0	0	0	0	0	0	0	0
TOTALS	0	2526	0	2530	0	2530	0	2532

Table A25. Weekly observed steelhead trout redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of August 31, 2009 to the week of October 19, 2009.

River Mile	8/31/2009	9/7/2009	9/14/2009	9/21/2009	9/28/2009	10/5/2009	10/12/2009[1]	10/19/2009
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	2

[1] Incomplete survey week and incomplete reaches.

Table A26. Weekly observed steelhead trout redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of October 26, 2009 to the week of December 14, 2009.

River Mile	10/26/2009	11/2/2009	11/9/2009	11/16/2009	11/23/2009	11/30/2009	12/7/2009	12/14/2009
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	2	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	1
15	1	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	1	0	0
20	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0
TOTALS	2	0	0	0	0	1	2	2

Table A27. Weekly observed steelhead trout redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of December 21, 2009 to the week of February 8, 2010.

River Mile	12/21/2009	12/28/2009	1/4/2010	1/11/2010	1/18/2010	1/25/2010	2/1/2010	2/8/2010
0	0	0	0	0				
1	0	0	0	0				
2	0	0	0	0				
3	0	0	0	0				
4	1	0	0	0				
5	0	0	0	0				
6	0	0	0	0				
7	0	0	0	0				
8	0	0	0	0				
9	0	0	0	0				
10	0	0	0	0				
11	0	0	0	1				
12	0	0	0	0	NO SURVEY	NO SURVEY	NO SURVEY	NO SURVEY
13	0	0	0	0				
14	0	0	0	0				
15	0	0	0	0				
16	0	0	0	0				
17	0	1	0	0				
18	0	0	0	0				
19	0	0	0	0				
20	0	0	1	0				
21	0	3	0	0				
22	0	0	0	0				
23	0	0	1	0				
24	0	0	0	0				
TOTALS	1	4	2	1	N/A	N/A	N/A	N/A

Table A28. Weekly observed steelhead trout redds by river mile in the surveyed reaches of the lower Yuba River, CA from the week of February 15, 2010 to the week of April 5, 2010.

River Mile	2/15/2010	2/22/2010	3/1/2010[1]	3/8/2010	3/15/2010	3/22/2010	3/29/2010	4/5/2010	All Weeks
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	2
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	2	0	0	0	0	2
8	1	1	0	0	2	0	0	0	4
9	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	1	0	1
11	0	0	0	2	1	2	0	0	8
12	1	0	0	0	1	0	0	0	2
13	1	0	0	0	0	1	0	0	2
14	0	0	0	0	0	1	0	0	2
15	1	0	0	4	2	1	3	1	13
16	0	0	0	2	1	5	7	5	20
17	0	1	0	6	6	5	2	2	23
18	0	3	0	1	0	3	2	2	11
19	5	1	0	21	5	21	13	2	70
20	1	0	0	0	19	3	19	6	49
21	0	0	2	0	8	3	5	5	26
22	0	0	0	0	0	0	0	0	0
23	3	0	0	0	0	0	0	0	5
24	0	0	0	0	0	0	0	0	0
TOTALS	13	6	2	38	45	45	52	23	241

[1] Incomplete survey week and incomplete reaches.