LOWER YUBA RIVER ACCORD MONITORING AND EVALUATION PLAN

CHINOOK SALMON ESCAPEMENT TECHNICAL MEMORANDUM FALL 2015

Prepared for: The Lower Yuba River Accord Planning Team

By

The Pacific States Marine Fisheries Commission

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1. PURPOSE

In 2011, the RMT developed new protocols and procedures to improve Chinook salmon escapement monitoring which will be used to meet goals of the lower Yuba River Accord's Monitoring and Evaluation Plan (M&E Plan). The Vaki Riverwatcher systems were recommended to be the sole source of annual Chinook salmon escapement estimation upstream of DPD. A biological sampling survey was recommended upstream of DPD to collect biological data (i.e., sex, fork length, scales, genetics, otoliths and female spawning status), recover coded-wire tags (CWTs), and other information (e.g., spatial/temporal information) from fresh Chinook salmon carcasses. A mark-recapture carcass survey was recommended for an escapement estimate downstream of DPD using a superpopulation modification of the Cormack-Jolly-Seber (CJS) model. Mark-recapture carcass survey methods were reviewed in the development of a Central Valley Adult Chinook Salmon Escapement Monitoring Plan and recommendations were made to use the CJS model to produce unbiased and precise estimates of escapement (Bergman *et al.* 2011). In the past, recapture rates of carcasses downstream of DPD were too low to estimate escapement using the modified-Schaefer model. Simulation modeling during the review found the CJS to produce reliable escapement estimates for population sizes as low as 250 fish (Bergman *et al.* 2011). In addition, the review found the modified-Schaefer model to be inappropriate for mark-recapture carcass surveys because assumptions of the model are violated and escapement estimates tended to exhibit an overestimation of population abundance in simulation modeling.

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 2011 escapement survey protocols and procedures developed in the M&E Program; and 3) provide annual stock recruitment data.

2. FIELD METHODS

The survey area extends from the Narrows Pool downstream to the Simpson Lane Bridge (32.2 km, **Figure 1**). Most of the Chinook salmon spawning habitat was included in this survey section; however, the stream reaches upstream of Narrows Pool has never been included in this survey due to remote inaccessibility and safety concerns. A crew of 3-6 persons using motorized vessels surveyed the entire survey area weekly.

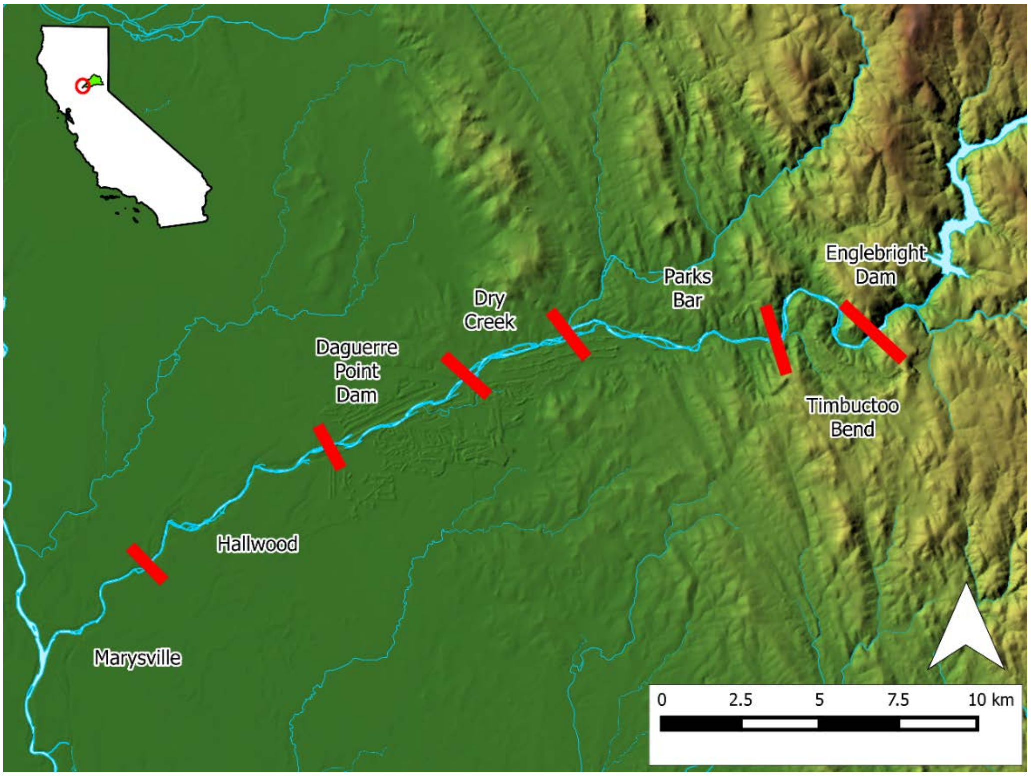

Figure 1. Map of the study area of the lower Yuba River, CA, showing the individual sample reaches.

The Vaki Riverwatcher was used to examine Chinook salmon passage into the reaches upstream of DPD and obtain an upstream net count that can be used to estimate total escapement. Specific sampling protocols and procedures for Vaki Riverwatcher monitoring are found in Appendix F of the M&E Plan.

A biological sampling survey was conducted in the survey reaches upstream of DPD to collect biological data from all fresh carcasses and recover CWTs from fresh adipose fin clipped carcasses. A fresh carcass was defined as having one clear eye and pink or red gills. Biological data included sex determination, fork length and female spawning status (i.e., spawned or unspawned). In addition, the location (river mile measured to the tenth) was recorded for each fresh carcass. Detailed protocols and procedures can be found in the Escapement Survey Protocols and Procedures[1].

A mark-recapture escapement survey (carcass survey) was conducted to estimate Chinook salmon escapement/abundance in the survey section below DPD, collect biological data, and recover coded-wire tags. Detailed methods can be found in the Escapement Survey Protocols and Procedures. All observed carcasses (ad-clipped and non-clipped) were subjected to tagging and biological sampling unless the carcass was deteriorated so that the presence of an adipose fin could not be determined, or length and sex could not be measured reliably. In addition, the location (river mile measured to the nearest tenth) was recorded for each carcass. Tagged carcasses were also identified as fresh or decayed to analyze biological data appropriately with data collected upstream of DPD. The upper maxillary of fresh adipose fin clipped carcasses was removed for CWT recovery. Carcasses were tagged with a uniquely numbered disc tag in the lower maxillary and then were released into the river. The disc tag number was recorded for all recaptured carcasses. If a recaptured carcass exhibited a high level of decomposition where the presence of the adipose fin could no longer be determined, the crew recorded the disc tag number, chopped the carcass, and recorded that the carcass was chopped. Otherwise all of the other recaptured carcasses were recorded and released for multiple recapture events.

2.1. Deviations from the Escapement Survey Protocols and Procedures

No genetic fin clip samples were collected at the direction of the RMT for the fall 2015 escapement. Scale samples and otoliths were obtained by subsampling (i.e. the 1st, 2nd, 5th, 10th, 15th…) fresh carcasses encountered during each survey day.

3. DATA ANALYSIS METHODS

3.1. Escapement Survey Process

A temporal description of each of the survey components was explained.

The number of fresh carcasses examined was enumerated.

Spawning status of fresh female carcasses was enumerated.

[1] Available online at http://www.yubaaccordrmt.com

3.2. Abundance

Abundance in the reaches upstream of DPD was defined as the total net upstream passage of Chinook salmon in the Vaki Riverwatcher systems. Net upstream passage is the number of upstream Chinook salmon passage events minus downstream passage events.

Analysis of the 2015 Escapement Survey mark-recapture data was performed using the superpopulation modification to the Cormack-Jolly-Seber model, utilizing code developed by West, Inc. for use in R (R Development Core Team 2011). The code allows for fitting models with sex and length covariates to mark-recapture data. Selecting more than one model allowed comparison of resultant QAICc values for each model which allowed us to choose a model based on the relative goodness of fit. Initial results showed a model using sex as a capture covariate and length as a survival covariate provided the highest relative goodness of fit of the statistical models. Data was run through the code, with these specifications, through five hundred bootstrap repetitions (Manly 2007), producing a 90% bootstrap confidence interval of the total escapement.

For a detailed description of the recommended survey protocol and statistical analysis procedures see Chapter 3 of the California Central Valley Chinook Salmon Escapement Monitoring Plan (Bergman *et al.* 2011).

Total abundance is the sum of the net Vaki count and the downstream escapement estimate.

4. RESULTS

4.1. Escapement Survey Process

The 2015 Chinook salmon biological sampling and mark-recapture carcass surveys were conducted beginning September 14, 2015 and ending January 4, 2016.

The 2015-2016 Vaki Riverwatcher Chinook salmon net passage data was collected from March 1, 2015 to February 29, 2016. The net upstream Chinook salmon count from the Vaki Riverwatcher systems was 4981.

During the biological sampling and mark-recapture carcass surveys, crews sampled 246 adult (≥650mm) and 139 grilse (<650mm) fresh Chinook salmon carcasses. Of the 246 fresh adult carcasses, 35 were adipose clipped (14.2%). Of the 139 fresh grilse carcasses, 27 were adipose clipped (19.4%).

Field crews visually inspected the spawning status of 215 female carcasses. Most carcasses were identified as spawned (n=201, or 93.5%) and the remainder were unspawned (n=14, or 6.5%). Comparing the ad-clipped and non-clipped carcasses, the percentage of females that were spawned and unspawned was 81.2% (n=26) and 18.8% (n=6) respectively for ad-clipped carcasses, and 95.6% (n=175) and 4.4% (n=8) for non-clipped carcasses.

Of all the 385 fresh carcasses examined, 63 were ad-clipped and heads were collected for subsequent CWT recovery by CDFW's Ocean Salmon Project. A total of 167 scale samples were collected during the biological sampling and mark-recapture carcass surveys and have also been provided to CDFW's Ocean Salmon Project. A total of 146 otoliths were collected during the escapement surveys and have been archived for later use.

The majority of fresh Chinook salmon carcasses (61.6%) were observed downstream of DPD in the Daguerre Point Dam, Hallwood, and Marysville reaches, the remaining 38.4% were observed upstream of DPD in the Timbuctoo Bend, Park's Bar, and Dry Creek reaches. Of the total number of fresh carcasses observed, 17.9% (n=69) were in the Timbuctoo Bend Reach, 17.4% (n=67) were in the Park's Bar Reach, 3.1% (n=12) were in the Dry Creek Reach, 38.2% (n=147) were in the Daguerre Point Dam Reach, 21.6% (n=83) were in the Hallwood Reach and 1.8% (n=7) were in the Marysville Reach **(Table 1, Figures 2 and 3)**. Peak fresh carcass observations for the entire survey area occurred during the week of November 16, 2015 **(Figure 4)**.

The mean fork length of fresh female salmon recovered in surveys was 711.3mm (95% CI 696.9 – 725.5mm). The mean fork length of fresh male salmon recovered in surveys was 702.9mm (95% CI 681.4 – 724.1mm). When split by adipose fin clip status, the mean fork length of non-clipped females was still 711.3mm (95% CI 696.4 – 727.6mm), and the mean fork length of clipped females was 710.9mm (95% CI 677.2 – 743.4mm). For males, non-clipped individuals had a mean fork length of 716.3mm (95% CI 691.9 – 740.2mm), while clipped individuals had a mean fork length of 640.2mm (95% CI 605.8 – 675.5mm). Length-frequency distributions for each group are shown in **Figure 5**.

Table 1. The number of fresh carcasses sampled in each surveyed reach by week, during the biological sampling and mark-recapture carcass surveys on the lower Yuba River, CA from September 14, 2015 to January 4, 2016.

	Timbuctoo Bend Reach	Park's Bar Reach	Dry Creek Reach	Daguerre Point Dam Reach	Hallwood Reach	Marysville Reach	Total
9/14/2015	0	0	0	0	0	0	0
9/21/2015	0	0	0	0	0	0	0
9/28/2015	0	0	0	0	0	0	0
10/5/2015	0	0	0	0	0	0	0
10/12/2015	1	1	0	0	0	0	2
10/19/2015	5	2	0	6	1	0	14
10/26/2015	12	5	2	7	5	1	32
11/2/2015	5	20	0	9	8	0	42
11/9/2015	4	8	1	32	15	0	60
11/16/2015	11	11	3	67	31	1	124
11/23/2015	13	7	1	14	5	0	40
11/30/2015	6	6	3	4	7	2	28
12/7/2015	7	2	0	1	2	1	13
12/14/2015	1	1	0	6	8	1	17
12/21/2015	2	2	1	0	0	0	5
12/28/2015	1	2	1	1	1	1	7
1/4/2016	1	0	0	0	0	0	1
Total	69	67	12	147	83	7	385
Percent	17.9%	17.4%	3.1%	38.2%	21.6%	1.8%	100%

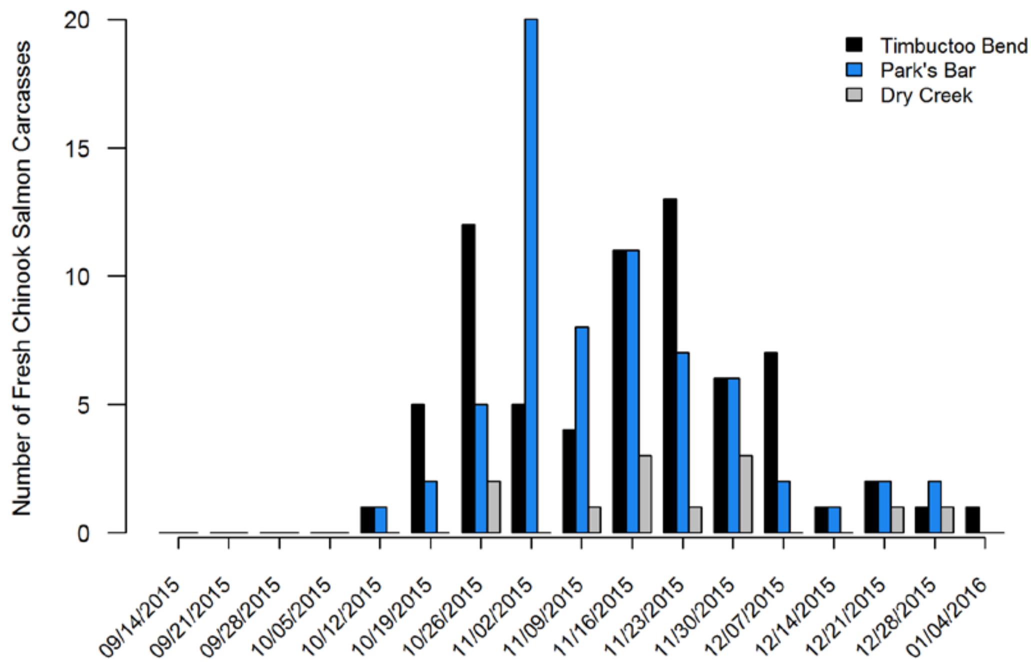

Figure 2. The number of fresh Chinook salmon carcasses observed upstream of Daguerre Point Dam in the Timbuctoo Bend, Park's Bar and Dry Creek reaches of the lower Yuba River, CA during a biological sampling carcass survey from September 14, 2015 to January 4, 2016.

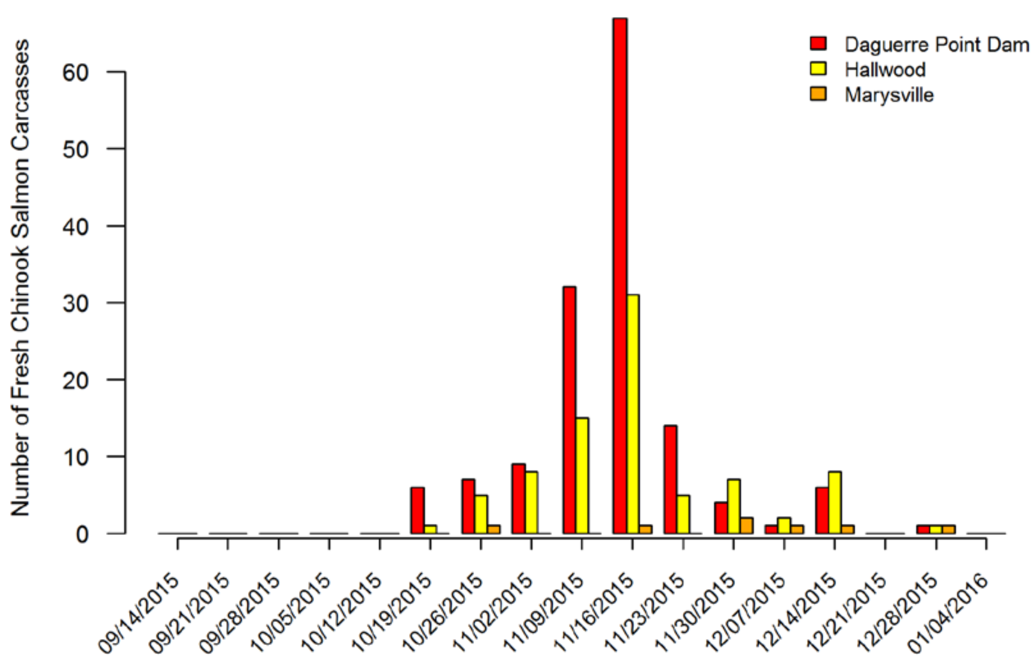

Figure 3. The number of fresh Chinook salmon carcasses observed downstream of Daguerre Point Dam in the Daguerre Point Dam, Hallwood and Marysville reaches of the lower Yuba River, CA during a mark-recapture carcass survey from September 14, 2015 to January 4, 2016.

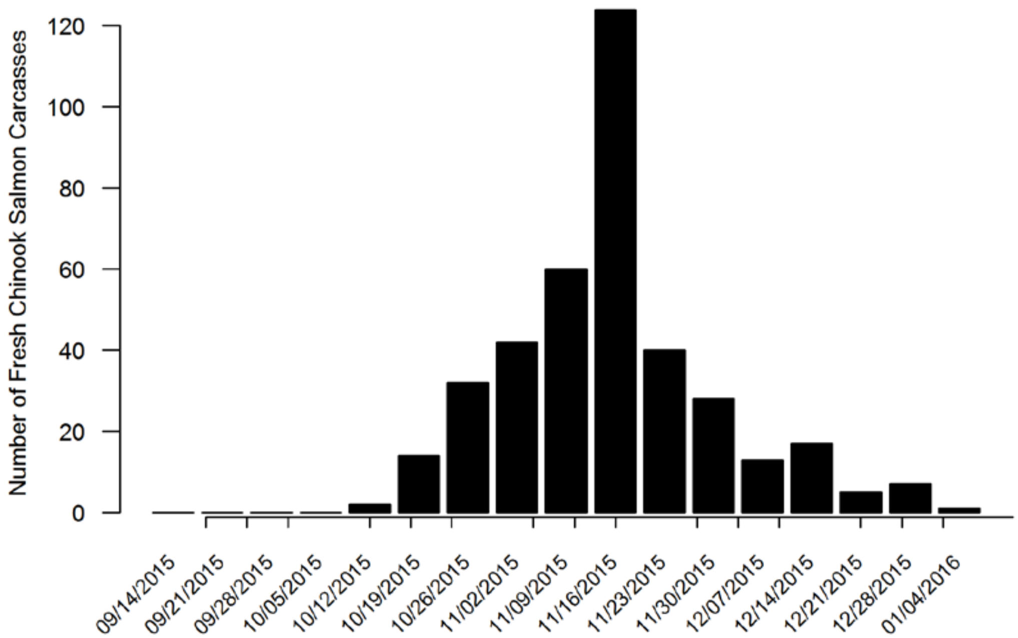

Figure 4. The number of fresh Chinook salmon carcasses observed in all surveyed reaches of the lower Yuba River, CA during the biological sampling and mark-recapture carcass surveys from September 14, 2015 to January 4, 2016.

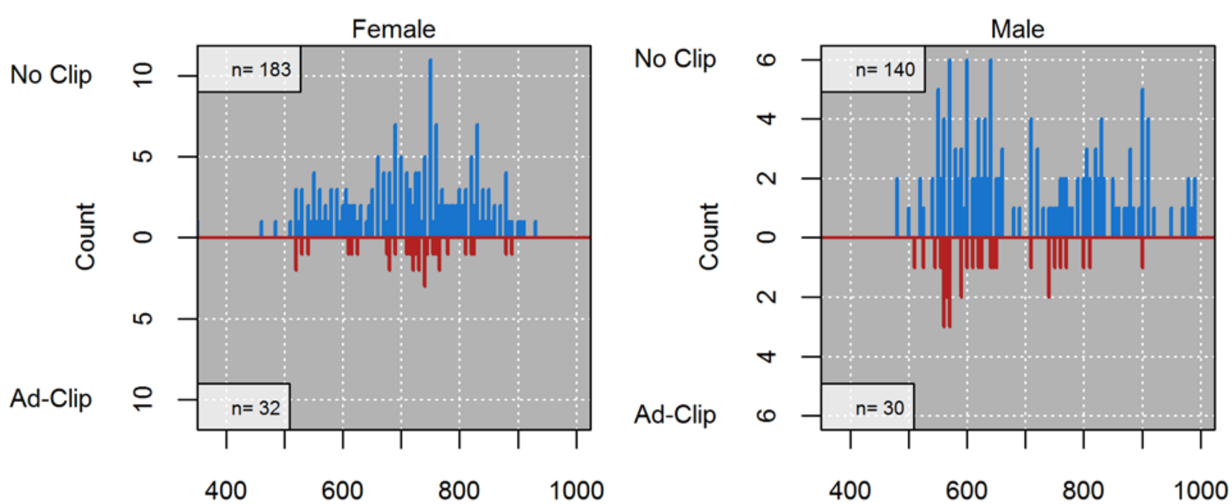

Figure 5. Length-frequency distributions for fresh Chinook salmon carcasses by sex and by adipose fin clip status. Number of individuals in each category is indicated.

Table 2. Release locations of adipose-fin clipped salmon examined for coded wire tags.

Hatchery	Basin	Age II	Age III	Age IV	Total
Feather River Fish Hatchery	Feather River	4	19	0	**23**
Coleman National Fish Hatchery	Sacramento River	14	0	0	**14**
Mokelumne River Fish Institute	Mokelumne River	5	7	2	**14**
Nimbus Fish Hatchery	American River	3	2	2	**7**
Merced River Fish Facility	Merced River	0	2	0	**2**
Total		**26**	**30**	**4**	**60**

4.2. Abundance

The abundance estimate downstream of DPD from the Cormack-Jolly-Seber model was 2,569. The 95% bootstrap percentile confidence interval for the total escapement was: 2,411 – 2,804. The male and female capture probabilities as calculated by the CJS model were 0.57 and 0.61, respectively.

The total escapement abundance of Chinook salmon (adult and grilse, upstream and downstream of DPD) returning to the lower Yuba River was estimated to be 7,550 (7392 – 7785, 95% CI). Harvest by recreational fisheries in the lower Yuba River was not incorporated into the abundance estimate.

5. ACKNOWLEDGEMENTS

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6. REFERENCES CITIED

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