

## TECHNICAL MEMORANDUM

<b>Date:</b>	December 18, 2024
<b>To:</b>	Erica Bishop – Sacramento Water Forum (Water Forum)
<b>From:</b>	Aaron Katz, Matthew Weber, and Chris Hammersmark – CBEC Eco Engineering, LLP (cbec); Pete Moniz, Jamie Sweeney, Kirsten Sellheim – Cramer Fish Sciences
<b>Project:</b>	24-1012 – Lower American River Emigrating Salmonid Habitat Estimator (ESHE) Support
<b>Subject:</b>	Lower American River Salmonid Rearing Habitat Quantification

### 1 INTRODUCTION

An updated two-dimensional (2D) HEC-RAS model was developed by CBEC Eco Engineering, LLP (cbec) for the Sacramento Water Forum (Water Forum) to represent 2023 conditions (cbec 2024b and 2024c). For this Project, the model was applied to estimate Chinook salmon rearing habitat within the lower American River (LAR). The 2D model simulated steady flows using 2023 topo-bathymetric LiDAR and sonar surveys to represent 2023 topography, bathymetry, and roughness conditions (cbec 2024a).

#### 1.1 BACKGROUND

Multiple planning processes utilize salmonid habitat availability estimates in order to inform decision support models. These planning processes range in scale from focusing on just the LAR to those that span a much larger area such as the entire Central Valley. An example of a local scale model is the Emigrating Salmon Habitat Estimator (ESHE) model that is being developed by Cramer Fish Sciences for the LAR. Larger geographic planning efforts include the Central Valley Project Improvement Act (CVPIA) Science Integration Team (SIT) to implement a Structured Decision Making (SDM) model, the Reorienting to Recovery Structured Decision Making model and the modeling conducted to support the Healthy Rivers and Landscape Program.

Prior to providing the results of this effort, related planning efforts relied upon an instream habitat study performed by USFWS in the 1980s, and inundation extents simulated with a regional hydraulic model designed to understand flooding impacts to estimate salmonid rearing habitat availability in the LAR. This technical memorandum seeks to update the LAR Chinook salmon rearing habitat information used in regional planning models (i.e., CVPIA SIT SDM, Reorienting to Recovery, and the State’s Healthy Rivers and Landscape Program decision support models). In addition, the results will be used to inform and to

provide existing habitat availability information for the LAR ESHE model developed by Cramer Fish Sciences.

## 1.2 STUDY OBJECTIVES

To estimate the amount of Chinook salmon fry and juvenile rearing habitat within the LAR across a wide range of flow conditions using an updated (i.e., 2023) digital elevation model (DEM), 2D hydraulic model, cover map, and LAR-specific Chinook salmon habitat suitability indices (HSIs).

## 2 METHODS

### 2.1 INPUT DATA

#### 2.1.1 DIGITAL ELEVATION MODEL

The DEM used for the Project consists of topo-bathymetric (“Green”) LiDAR data collected by NV5 Geospatial in December 2023 (NV5 Geospatial 2024) combined with single- and multi-beam sonar collected by cbec in April 2023 through April 2024. These data sets were reviewed for accuracy and consistency, compiled and constructed into a raster DEM by cbec (2024a). For hydraulic modeling, the DEM was constructed as a 3 ft raster surface, and bridge piers were incorporated into the HEC-RAS Terrain. Combined, these datasets provide the best available, seamless, high-resolution (3 ft raster grid) topography and bathymetry for the entire LAR.

#### 2.1.2 HEC-RAS MODEL

The full model domain extends from Nimbus Dam to the confluence with the Sacramento River (cbec 2024b). To limit and optimize model simulation times, the full LAR domain was split into an upper and lower domain at Watt Avenue. Within each domain, separate models were created for ecological flows (i.e., 500 to 20,000 cfs) and flood flows (i.e., 20,000 to 160,000 cfs). Each model had unique geometries with slightly different computational meshes and channel Manning’s n values. A landcover map was created using a combination of NAIP imagery and the LiDAR point cloud to classify the active channel, vegetation communities, bare earth, and developed areas. Spatially resolved Manning’s n values were assigned to the landcover categories and input into the model geometries. Ecological flows were calibrated to flows ranging from 2,060 to 7,030 cfs, and flood flows were calibrated to flows ranging from 20,000 to 134,000 cfs.

#### 2.1.1 HABITAT SUITABILITY INDEX DEVELOPMENT

Water depth, water velocity, and cover type HSI values were developed for rearing Chinook salmon using snorkel data collected in the LAR by Cramer Fish Sciences each spring from 2022 to 2024. Snorkel transects were conducted from Nimbus Basin downstream to Harrington Access at restoration sites and unrestored control locations at flows ranging from 1,010 to 16,100 cfs (Figure 1). Species, count, and size class (0-50 mm, 51-80 mm, 81-100 mm, 101-120 mm, 121-150 mm, 151-200 mm, 201-300 mm, and >301 mm) of each observed fish were recorded. For salmonid observations, fish location and physical habitat characteristics (e.g., depth, velocity, and dominant and subdominant cover and substrate) were recorded. Depth was measured using a USGS top setting wading rod and depth-averaged velocity was measured

using an electromagnetic Hach FH 950 flow meter. Cover and substrate were assessed within a 0.5 m<sup>2</sup> area of each fish observation. Cover types included woody material, aquatic vegetation or algae, overhanging vegetation, emergent vegetation, undercut banks, boulders, cobble, or none of the above. Substrate types included boulders, cobble, gravel, pea gravel, and sand/fines. In addition to the data collected at fish observations, physical habitat data were also collected at random stations within the survey area to account for available habitat not utilized by rearing Chinook salmon. If a random station fell within 1 m of a fish observation, physical data were not recorded. A more detailed description of these methods can be found in Cramer Fish Sciences (2020).

For this analysis, observations of Chinook salmon in the 0-50 mm size class were considered fry (Apgar et al. 2020), while those in the 50-80 mm size class were considered juveniles. Chinook salmon greater than 80 mm were assumed to be emigrating smolts (Zeug et al. 2014) and were therefore removed from further analysis.

#### **2.1.1.1 DEPTH AND VELOCITY SUITABILITY INDEX**

Two methods were used to develop and compare depth and velocity HSI values for fry and juvenile Chinook salmon using the snorkel data described above. First, logistic regression models were developed in R for both life stages using methods similar to Beakes et al. (2014). These models incorporate depth and velocity data from where rearing Chinook salmon were observed (utilized habitat) and at random stations where they were not (available habitat) to predict the probability of habitat occupancy. Probability values were then rescaled to the traditional HSI range of 0 to 1. A second set of HSI values were also developed using nonparametric tolerance limits (NPTLs) at the 95% confidence level. This method assigns HSI values to varying ranges of depths and velocities utilized by rearing Chinook salmon. A more detailed description of this method can be found in Bovee (1986) and Moniz et al. (2020).

The two methods produced relatively similar ranges and peaks in depth and velocity HSI values for fry and juvenile Chinook salmon. However, a few juveniles observed in relatively deep habitat (i.e., > 4 ft) coupled with a lack of random stations in similarly deep habitat resulted in an inverse of the depth HSI values commonly observed for juvenile Chinook salmon. According to the model, the lowest HSI values were in shallow habitat (< 3 ft) where most of the juvenile Chinook salmon were observed while the highest HSI values were in deep habitat (> 10 ft) where no juveniles were observed. Given this counter-intuitive result and because similar habitat suitability models for rearing Chinook salmon fry and juveniles have been extensively tested in the lower Yuba River using NPTLs (Moniz et al. 2020), the NPTL HSI values were chosen for this analysis (Figure 2).

#### **2.1.1.2 COVER SUITABILITY INDEX**

Cover HSI values were developed for a subset of cover types that could be mapped in GIS, including woody/herbaceous vegetation, woody material, cobble/boulder, and none of the above. Dominant cover types originally recorded in the snorkel data as overhanging or emergent vegetation were re-classified as woody/herbaceous vegetation for consistency. Dominant cover types recorded as aquatic vegetation, algae, or undercut banks were re-classified as their subdominant cover type or dominant/subdominant substrate type if they matched any of the cover types listed above that could be mapped in GIS. All other cover types were re-classified as “none of the above”. The proportion of each cover type utilized by rearing

Chinook salmon was then divided by the proportion available for both life stages, and then divided again by the highest value for each life stage resulting in cover HSI values ranging from 0 to 1 (Figure 3).

### 2.1.2 COVER MAP DEVELOPMENT

To incorporate cover into the habitat suitability calculation, the landcover map used for the hydraulic model was re-categorized to represent cover types used by rearing salmonids. These potential cover types include woody/herbaceous vegetation, large woody material (LWM), cobble/boulder, and none of the above (Figure 2). Woody vegetation included the classes of “Small Tree,” “Medium Tree,” and “Large Tree,” and herbaceous vegetation included “Grass.” Locations of individually placed LWM were taken from as-built plansets from previously implemented LAR Salmonid Habitat Enhancement Program projects. In-channel cobble/boulder areas were determined by correlating multibeam sonar roughness values to areas of known cobble that were placed as part of the LAR Salmonid Habitat Enhancement Program projects. Overbank cobble and boulder areas were manually digitized using aerial imagery to delineate areas of exposed bar surfaces adjacent to riffle locations. Overbank cobble/boulder areas were not mapped downstream of Gristmill Recreation Area because the channel gradient drops significantly at this location and the river channel and banks are composed primarily of sand and engineered revetments.

## 2.2 HYDRAULIC MODEL SIMULATIONS

Steady inflow simulations were modeled using the updated HEC-RAS 2D hydraulic models for baseflow (i.e., 500 cfs) up to the peak design discharge for the LAR (i.e., 160,000 cfs). The ecological flow model (cbec 2024b) was used for flows below 20,000 cfs and the flood flow model (cbec 2024c) was used for flows 20,000 cfs and greater. Flows modeled include: 500, 750, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 6000, 7000, 8000, 9000, 10000, 12500, 15000, 30000, 45000, 70000, 115000, and 160000 cfs.

## 2.3 HABITAT QUANTIFICATION

The depth and velocity results from the hydraulic model simulations were combined with the cover map to calculate the HSI values. For each flow, the hydraulic results rasters (depth and velocity) for the lower and upper domain were merged to analyze the full LAR. Depth and velocity HSI (DHSI and VHSI) were calculated using the curves shown in Figure 1, and cover HSI (CHSI) was calculated using the values provided in Figure 2. Hydraulic HSI (hHSI) was calculated as the geometric mean of DHSI and VHSI, and global HSI (gHSI) was calculated as the geometric mean of DHSI, VHSI, and CHSI (see equations 1 and 2 below). Suitable habitat was calculated as the total area of hHSI and gHSI greater than or equal to 0.5 (Moniz et al. 2020, Moniz & Pasternack 2021) (Equation 3). This method differs from the traditional weighted usable area (WUA) approach and was selected because WUA can overestimate functional habitat areas when there is abundant poor and low quality habitat. The equations are shown below,

$$hHSI_{cell} = \sqrt{DHSI * VHSI} \quad (1)$$

$$gHSI_{cell} = \sqrt[3]{DHSI * VHSI * CHSI} \quad (2)$$

$$\text{Suitable Habitat: } gHSI \text{ or } hHSI \geq 0.5 \quad (3)$$

where hHSI, DHSI, VHSI, gHSI, CHSI are hydraulic, depth, velocity, global, and cover habitat suitability indices.

Additional post-processing scripts were used to calculate the area of suitable habitat at each flow rate for each life stage segregated between the active channel and the floodplain and for each 0.5 river kilometer (Tables A1 – A3, Appendix A). The wetted extent of 1,250 cfs was used to delineate the active channel.

## 3 RESULTS

### 3.1 SUITABLE CHINOOK SALMON FRY REARING HABITAT

Suitable rearing habitat with and without cover (hHSI and gHSI, respectively) for Chinook salmon fry is shown for flows between 500 and 160,000 cfs in Figure 4. From base flow, hydraulic HSI (i.e., without cover) decreases to 9,000 cfs, then increases to a peak at 30,000 cfs. As flow increases so do channel depths and velocities, so suitable fry habitat becomes less available until significant portions of the floodplain become inundated, where depths and velocities are lower (i.e., more suitable). At flood flows greater than at 30,000 cfs, suitable habitat decreases to 115,000 cfs.

When the presence and type of cover is included in the calculations for global HSI, smaller amounts of suitable habitat are available for flows less than 5,000 cfs compared to purely hydraulic habitat (hHSI). Global HSI (i.e., with cover) reaches a minimum at 1,500 cfs before starting to increase as vegetated areas (the most common form of cover) start to be inundated. Most areas of the channel that contain other types of cover (primarily cobbles and boulders), are likely too deep to provide suitable fry habitat.

Figure 5 shows the amount of channel and floodplain suitable habitat ( $gHSI \geq 0.5$ ) for Chinook salmon fry for each of the flows analyzed. For flows up to 1,500, all suitable habitat is contained within the active channel (1,250 cfs wetted extent). Between 1,750 and 4,000 cfs, the proportion of floodplain habitat increases until all habitat is contained in the floodplain. Tabular values for the amount of suitable Chinook salmon fry rearing habitat per flow is provided in Table A1, and the amount of habitat area for each 0.5 river kilometer bin at select flow rates analyzed is included in Table A2.

### 3.2 SUITABLE CHINOOK SALMON JUVENILE REARING HABITAT

Suitable rearing habitat with and without cover (hHSI and gHSI, respectively) for Chinook salmon juveniles is shown for flows between 500 and 160,000 cfs in Figure 6. Figure 7 shows the amount of channel and floodplain suitable habitat ( $gHSI \geq 0.5$ , with cover included) for Chinook salmon juveniles for each of the flows analyzed. In general, the trend of Chinook salmon juvenile suitable rearing habitat availability mirrors that of fry habitat, but juvenile habitat is greater in magnitude. This is expected given that juveniles can withstand higher velocities and depths than fry and benefit from similar cover conditions. The proportion of active channel to floodplain habitat for juvenile habitat also generally mirrors the trend shown for fry habitat availability. Tabular values for the amount of suitable Chinook salmon juvenile

rearing habitat per flow is provided in Table A1, and the amount of suitable juvenile rearing habitat area for each 0.5 river kilometer bin at select flow rates analyzed is included in Table A3.

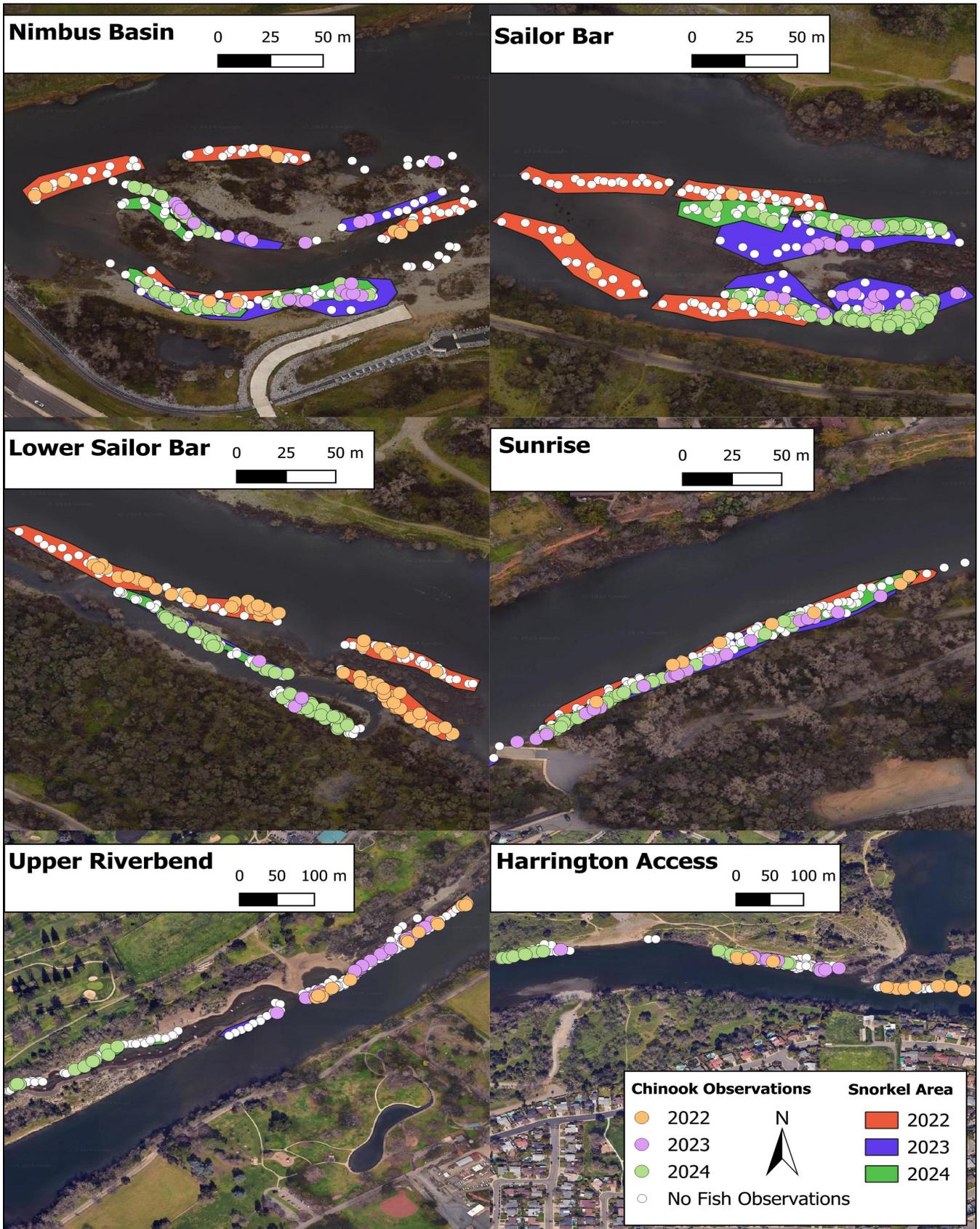
## 4 CONCLUSIONS

This analysis provides the best-to-date quantification of Chinook salmon fry and juvenile habitat availability within the LAR over a comprehensive range of flows. The updated DEM, hydraulic model, and habitat suitability curves developed specifically for the LAR further increases the accuracy of these results. The models used here can be applied to quantify the availability of habitat for other salmonid species (e.g., Steelhead) and/or other Chinook salmon lifestages.

## 5 REFERENCES

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## FIGURES



Notes: Snorkel surveys performed by Cramer Fish Sciences

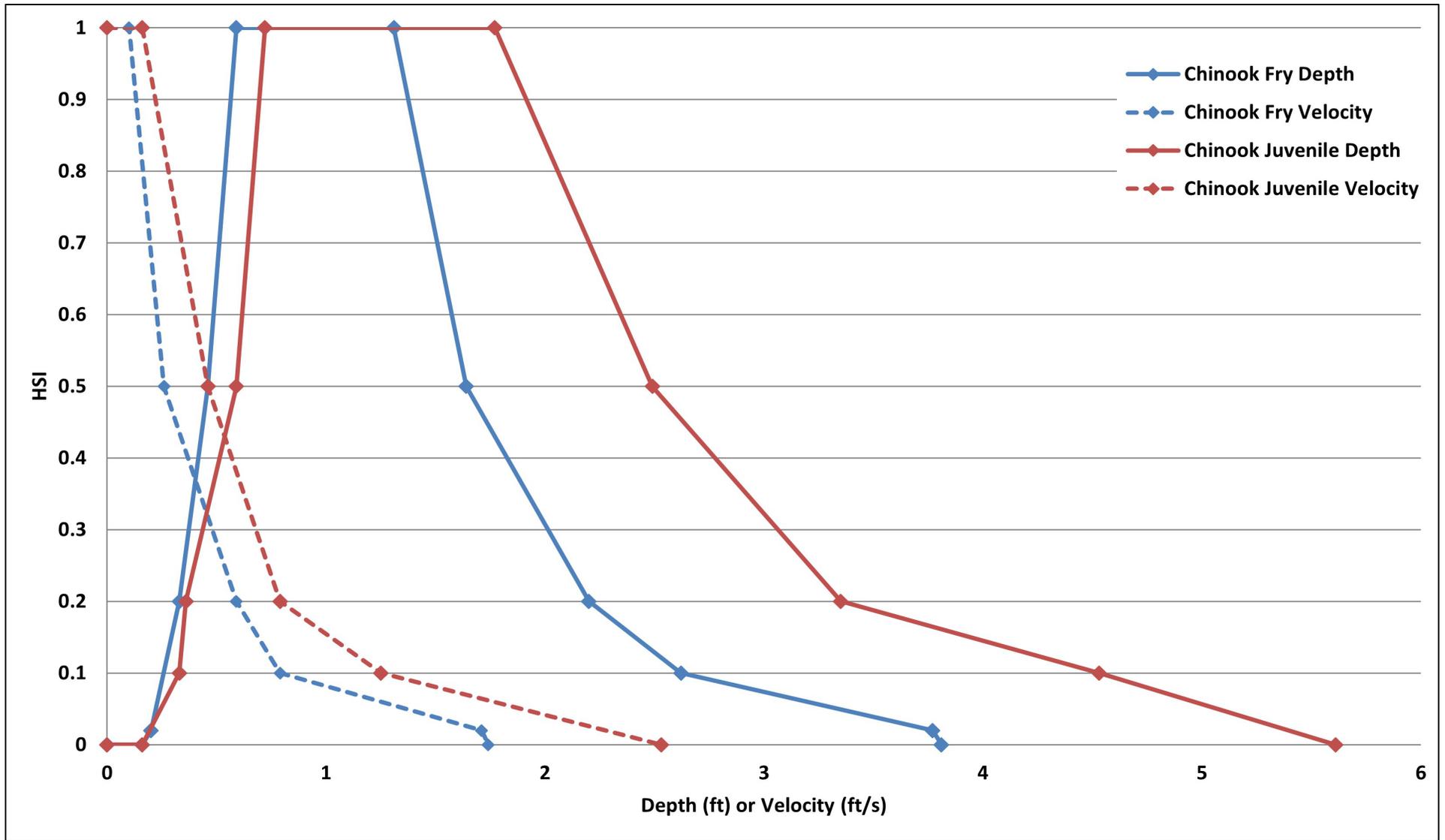


LAR Emigrating Salmonid Habitat Estimator Support  
Chinook observations from snorkel surveys used to create HSI curves

Project No. 24-1012

Created By: ACK

Figure 1



Notes: Developed by Cramer Fish Sciences

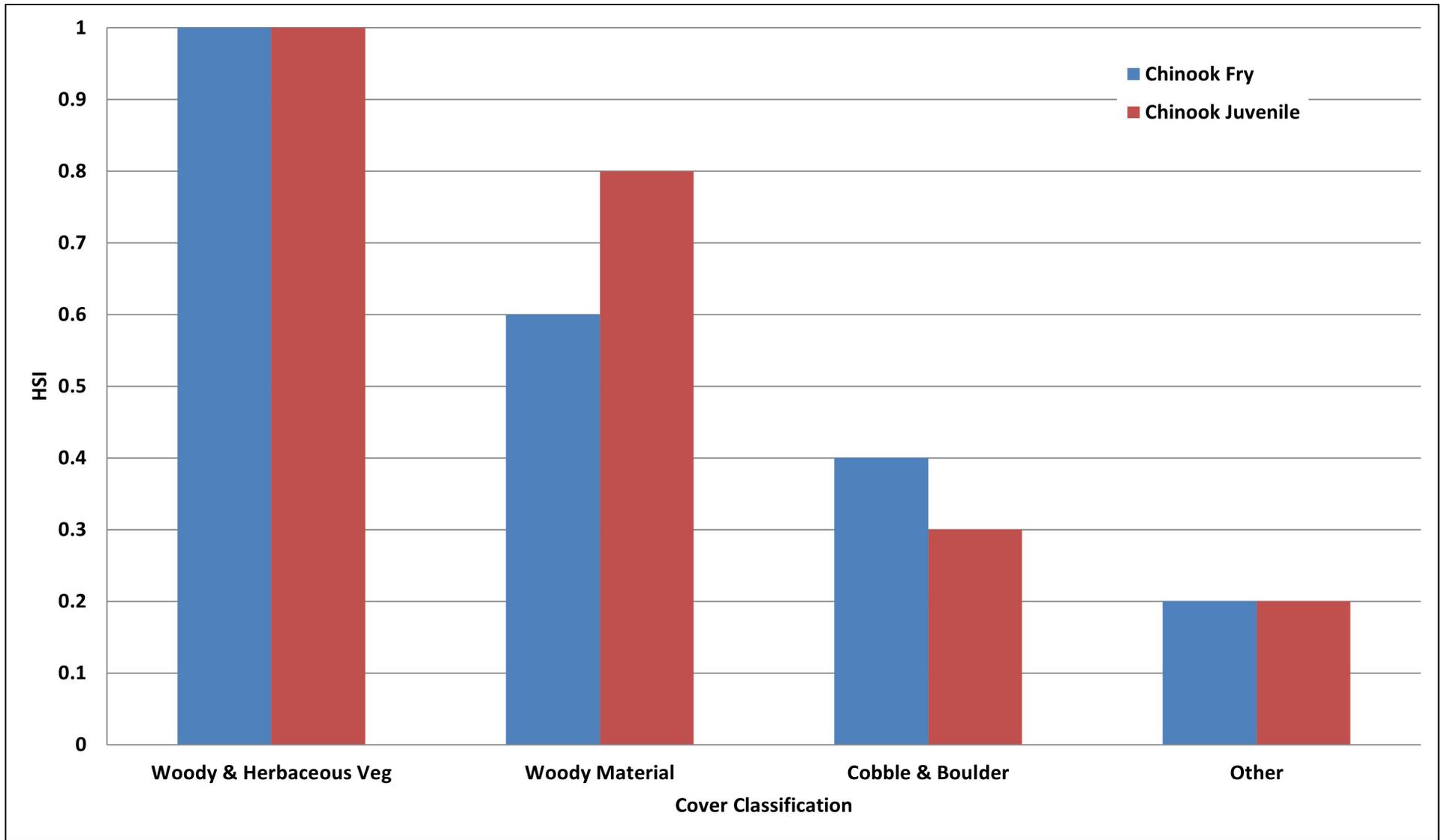


LAR Emigrating Salmonid Habitat Estimator Support  
 Hydraulic HSI curves for Chinook fry and juveniles

Project No. 24-1012

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Figure 2



Notes: Developed by Cramer Fish Sciences



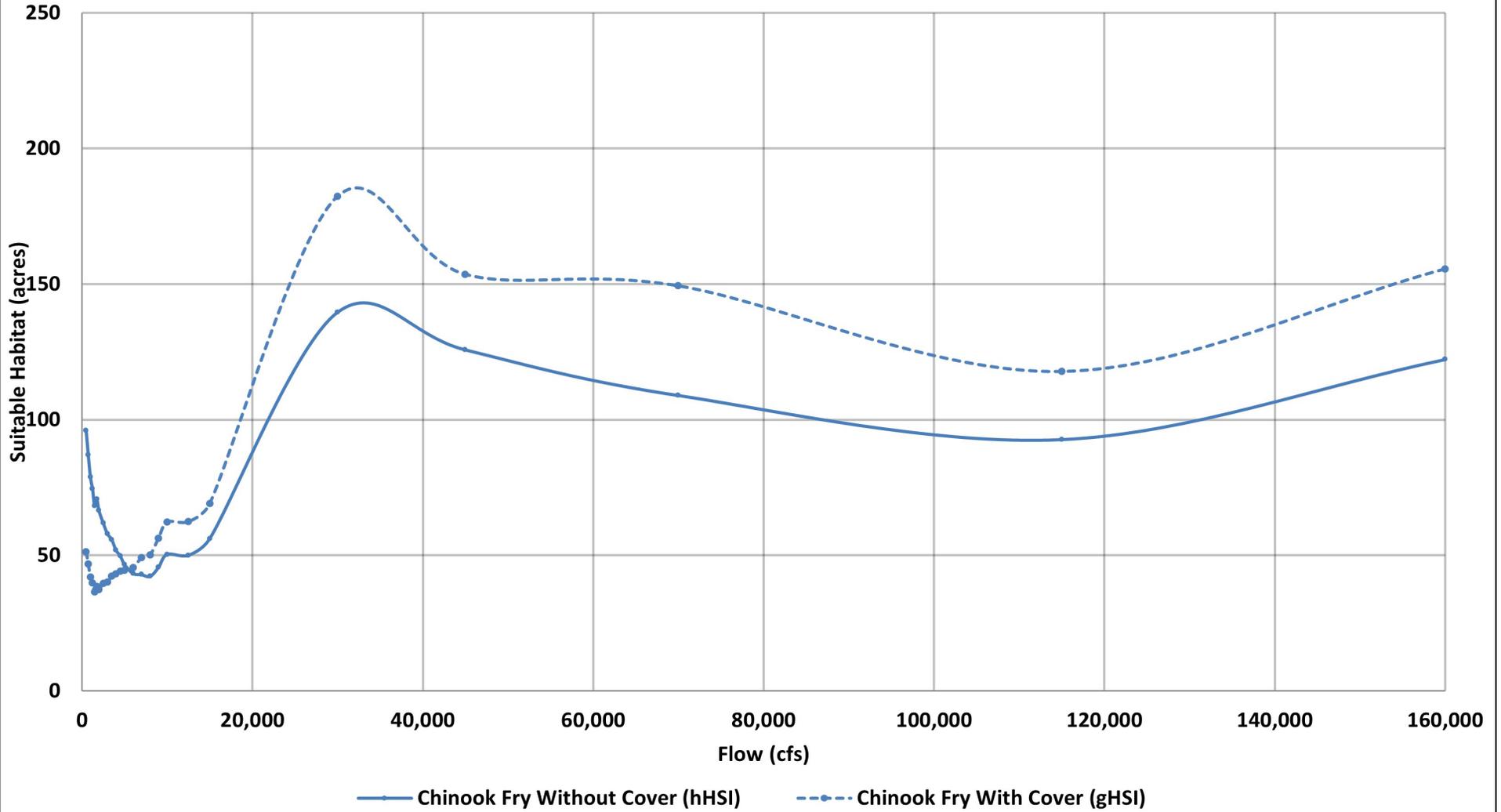
LAR Emigrating Salmonid Habitat Estimator Support  
**Cover HSI values for Chinook fry and juveniles**

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**Figure 3**

**Chinook Fry - Suitable Habitat (hHSI/gHSI > 0.5)**



Notes: Suitable habitat determined by hHSI/gHSI ≥ 0.5



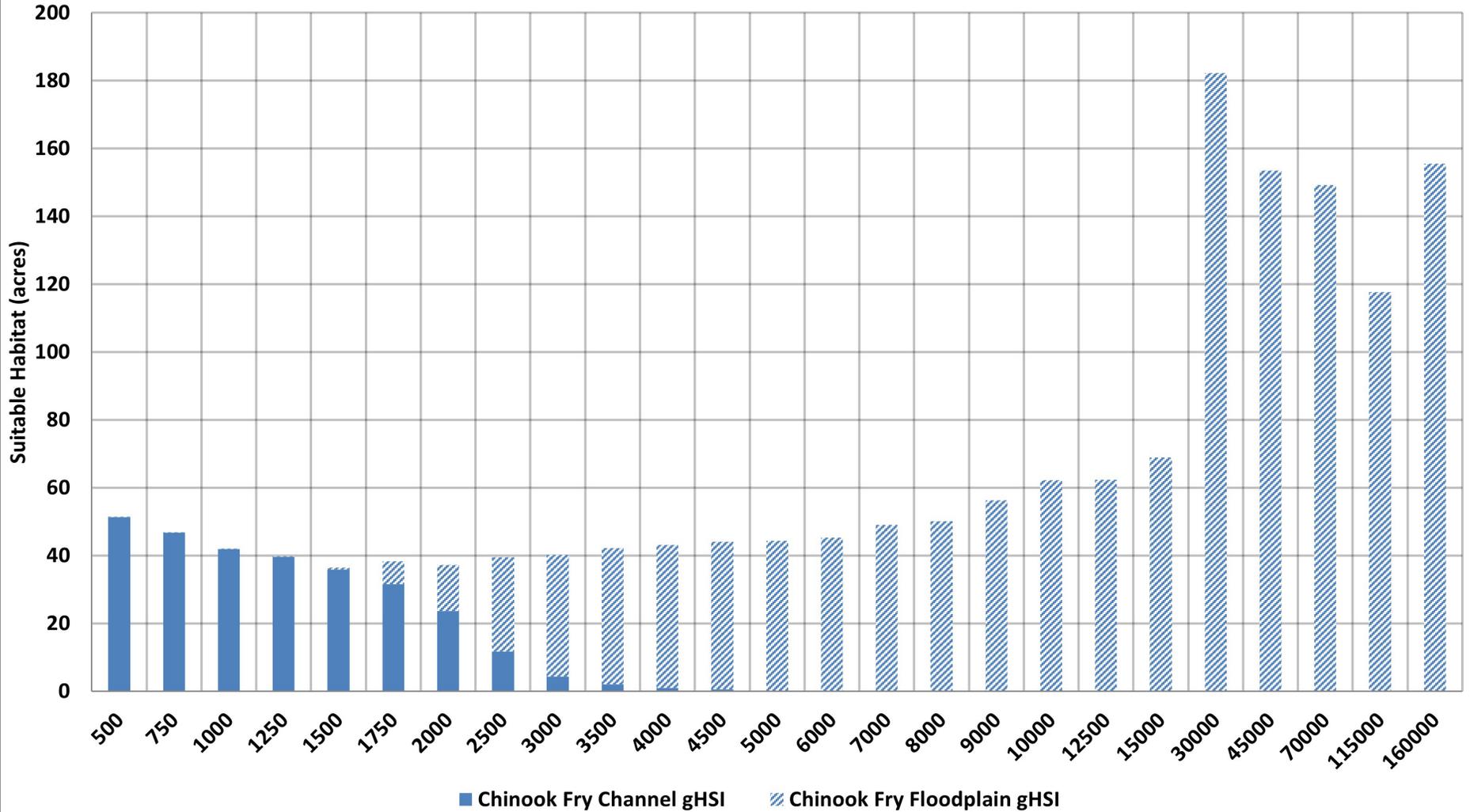
LAR Emigrating Salmonid Habitat Estimator Support  
**Suitable rearing habitat acreage for Chinook fry by flow**

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**Figure 4**

### Chinook Fry Channel-Floodplain gHSI Suitable Habitat



Notes: Suitable habitat determined by hHSI/gHSI ≥ 0.5

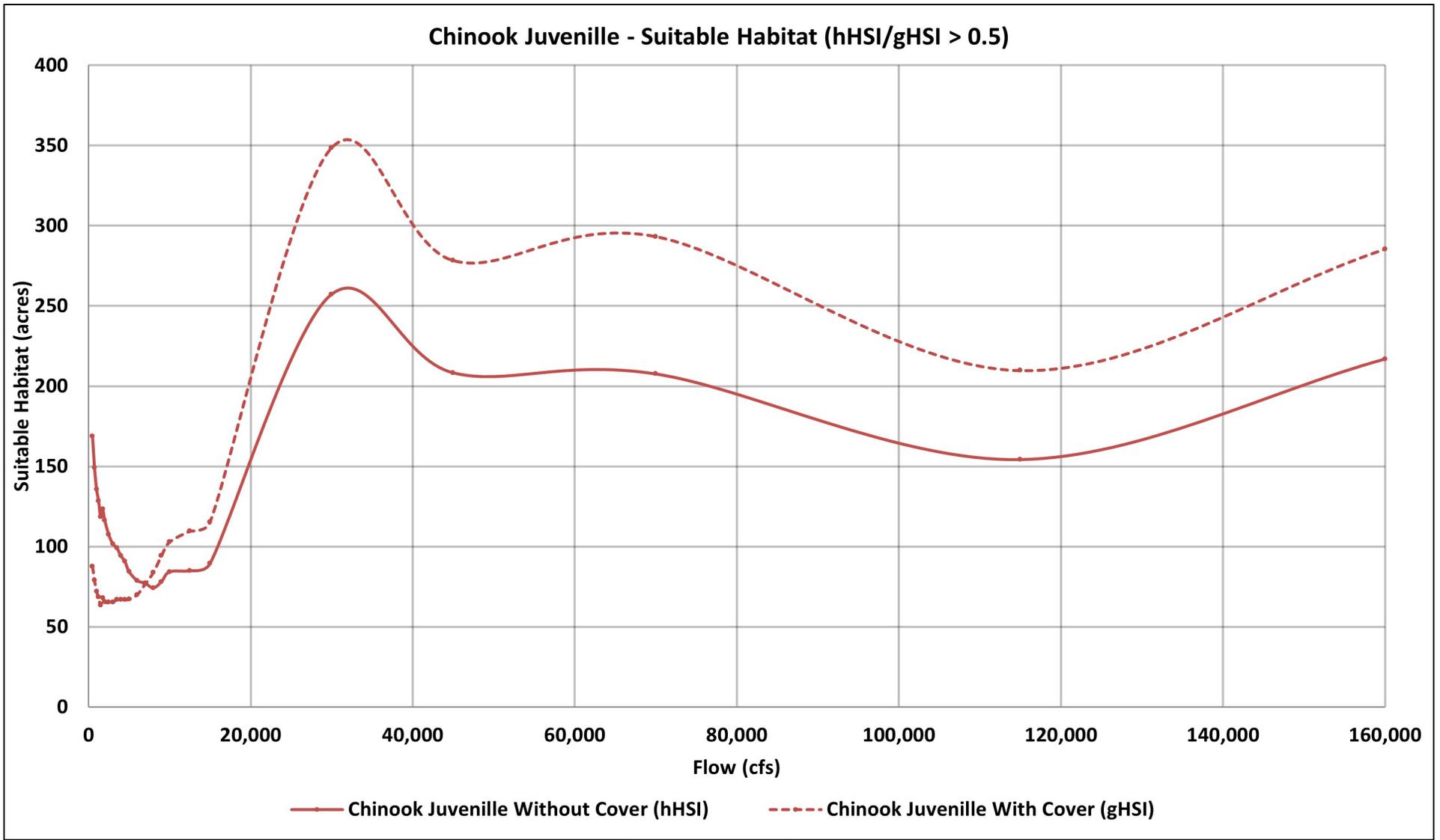


LAR Emigrating Salmonid Habitat Estimator Support  
 Suitable rearing habitat acreage in channel versus floodplain for Chinook fry

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Figure 5



Notes: Suitable habitat determined by hHSI/gHSI ≥ 0.5



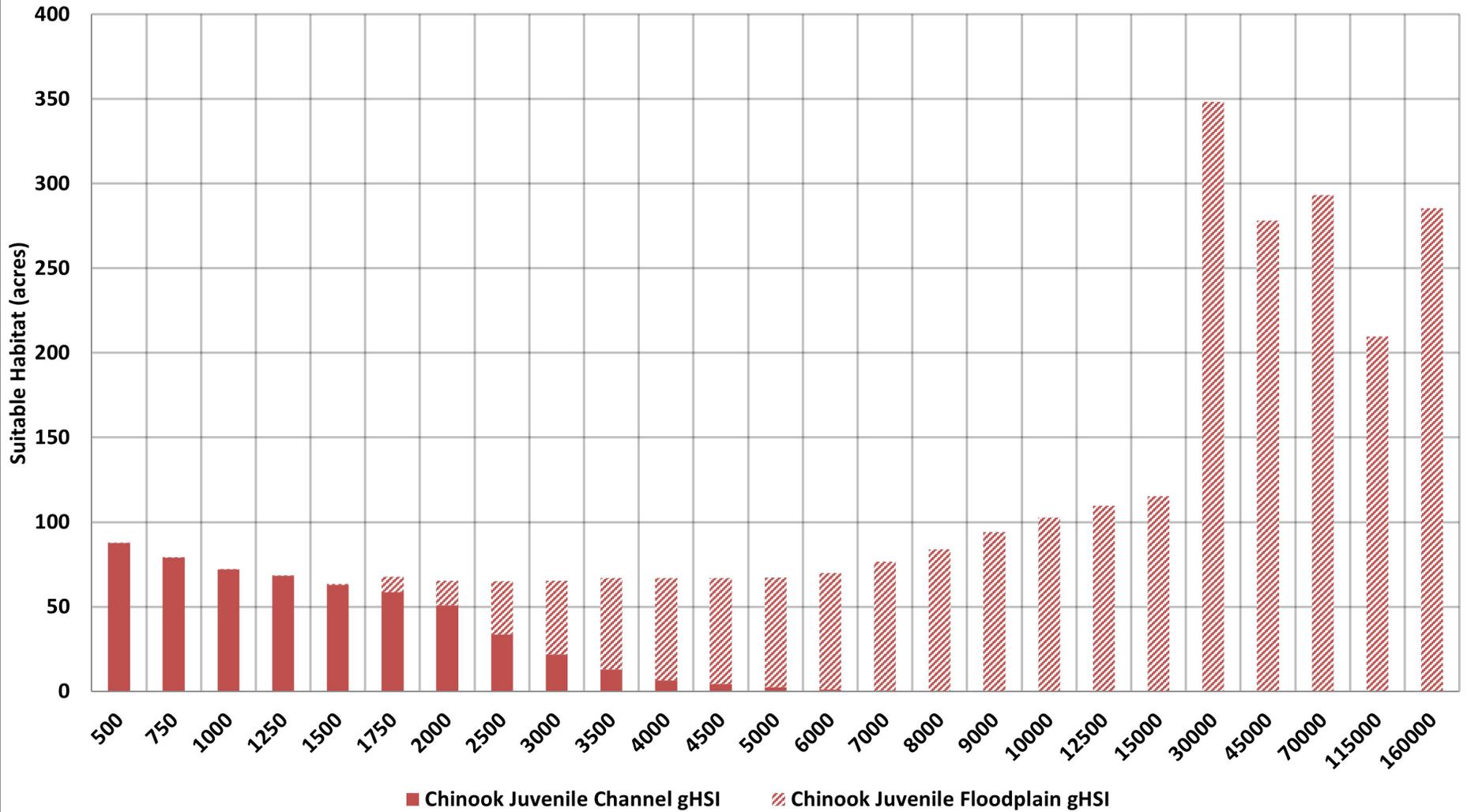
*LAR Emigrating Salmonid Habitat Estimator Support*  
**Suitable rearing habitat acreage for Chinook juvenile by flow**

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**Figure 6**

### Chinook Juvenile Channel-Floodplain gHSI Suitable Habitat



Notes: Suitable habitat determined by hHSI/gHSI ≥ 0.5



LAR Emigrating Salmonid Habitat Estimator Support  
 Suitable rearing habitat acreage in channel versus floodplain for Chinook juvenile

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Figure 7

**APPENDIX A -  
LOWER AMERICAN RIVER CHINOOK REARING HABITAT TABLES**

**Table A1.** Suitable Chinook salmon rearing habitat for the lower American River

Flow (cfs)	Suitable Habitat: gHSI ≥ 0.5 (acres)					
	Chinook Salmon Fry			Chinook Salmon Juvenile		
	Channel	Floodplain	Total	Channel	Floodplain	Total
500	51.276	0.000	51.276	87.572	0.000	87.573
750	46.731	0.000	46.731	79.008	0.001	79.009
1000	41.913	0.000	41.913	72.048	0.001	72.048
1250	39.675	0.000	39.676	68.387	0.000	68.388
1500	35.894	0.515	36.410	62.917	0.408	63.325
1750	31.583	6.792	38.375	58.513	9.325	67.838
2000	23.705	13.595	37.300	50.721	14.726	65.447
2500	11.771	27.718	39.489	33.706	31.470	65.176
3000	4.295	35.851	40.147	21.676	43.577	65.254
3500	2.035	40.155	42.190	13.046	53.947	66.993
4000	1.037	42.071	43.108	6.598	60.223	66.821
4500	0.528	43.550	44.078	4.456	62.363	66.819
5000	0.249	44.081	44.329	2.552	64.645	67.198
6000	0.077	45.280	45.357	1.144	68.814	69.958
7000	0.040	48.971	49.011	0.523	76.122	76.645
8000	0.020	50.077	50.098	0.204	83.659	83.863
9000	0.007	56.256	56.263	0.110	94.043	94.153
10000	0.004	62.167	62.170	0.065	102.742	102.807
12500	0.003	62.344	62.347	0.027	109.671	109.698
15000	0.001	68.985	68.986	0.021	115.235	115.256
30000	0.000	182.233	182.233	0.000	348.429	348.429
45000	0.000	153.513	153.513	0.000	278.267	278.267
70000	0.000	149.273	149.273	0.000	293.211	293.211
115000	0.000	117.702	117.702	0.000	209.695	209.695
160000	0.000	155.533	155.533	0.000	285.400	285.400

**Table A2.** Suitable Chinook fry rearing habitat by 0.5 river kilometer in the lower American River

River Kilometer	Chinook Fry Suitable Rearing Habitat (gHSI $\geq$ 0.5) (Acres)					
	500 cfs	2,000 cfs	4,000 cfs	8,000 cfs	15,000 cfs	30,000 cfs
0	0.334	0.365	0.198	0.124	0.173	0.740
0.5	0.946	0.485	0.291	0.319	0.614	12.136
1	0.550	0.315	0.818	0.548	1.766	8.224
1.5	0.688	0.350	0.255	0.388	0.507	15.187
2	0.383	0.373	0.257	0.717	0.935	6.020
2.5	0.554	0.367	0.220	0.317	0.842	12.229
3	0.585	0.410	0.314	0.433	0.299	18.011
3.5	0.336	0.333	0.280	0.425	0.335	11.392
4	0.525	0.454	0.283	0.302	0.718	20.164
4.5	1.164	0.646	0.487	0.564	1.270	9.452
5	1.673	0.394	0.240	0.495	0.867	9.094
5.5	0.943	0.457	0.221	0.443	1.110	1.830
6	1.467	0.543	0.352	0.689	0.862	6.951
6.5	0.845	0.349	0.588	0.511	3.094	1.276
7	0.218	0.254	0.226	0.681	3.989	1.619
7.5	0.849	0.524	0.370	1.011	3.016	0.705
8	0.677	0.225	0.579	0.668	1.092	1.024
8.5	0.853	0.622	0.711	1.498	1.426	1.005
9	0.507	0.396	0.429	0.905	1.512	2.467
9.5	0.566	0.257	0.225	0.763	0.740	1.696
10	0.535	0.051	0.100	0.426	0.376	0.638
10.5	0.316	0.217	0.343	0.590	0.300	0.072
11	0.144	0.220	0.277	0.589	0.832	0.204
11.5	0.192	0.167	0.301	0.566	0.823	0.758
12	0.698	0.511	0.359	0.316	1.436	1.717
12.5	0.566	0.351	0.321	0.256	0.876	1.301
13	1.636	2.124	1.468	0.797	1.154	1.513
13.5	0.309	0.469	5.420	3.044	2.254	0.985
14	0.381	0.942	0.965	0.847	1.944	0.890
14.5	1.010	0.772	0.670	0.831	2.070	2.195
15	0.304	0.035	0.215	0.491	0.282	0.356
15.5	0.498	0.041	0.170	0.246	0.278	1.431
16	0.623	0.264	0.331	0.135	0.131	0.398
16.5	0.751	0.517	0.746	0.771	1.355	1.155
17	1.026	1.898	1.454	1.017	1.667	1.043
17.5	1.969	2.663	2.406	3.609	2.942	1.411
18	1.366	2.449	2.283	0.880	0.799	0.550
18.5	0.872	0.592	0.541	0.848	0.607	0.595
19	0.579	0.625	0.572	0.615	0.558	2.140
19.5	0.363	1.313	1.517	1.426	2.382	2.050
20	0.968	0.783	0.797	0.937	1.480	0.570
20.5	0.802	1.650	2.088	2.989	3.113	1.493
21	1.169	0.839	1.182	2.491	2.964	4.183
21.5	0.913	0.437	0.220	0.267	0.299	0.535
22	0.579	0.132	0.181	0.189	0.229	0.101
22.5	0.615	0.220	0.164	0.209	0.242	0.076
23	0.517	0.429	0.462	0.484	1.147	0.793
23.5	0.995	0.212	0.346	0.498	0.562	0.863
24	0.624	0.305	0.256	0.330	0.392	1.112
24.5	1.229	0.355	0.605	1.077	0.577	0.512
25	0.719	0.295	0.480	0.755	0.930	1.111
25.5	0.487	0.292	0.357	0.474	0.432	1.005
26	0.388	0.236	0.616	0.610	0.586	0.599
26.5	0.505	0.206	0.341	0.420	0.430	0.315
27	0.183	0.049	0.138	0.165	0.228	0.097
27.5	0.521	0.254	0.300	0.185	0.201	0.171
28	0.397	0.402	0.265	0.431	0.381	0.512
28.5	0.324	0.148	0.267	0.243	0.691	1.258
29	0.276	0.192	0.203	0.329	0.991	0.814
29.5	0.312	0.257	0.368	0.404	0.342	0.471
30	0.395	0.085	0.123	0.096	0.067	0.303
30.5	0.829	0.569	0.647	0.465	0.275	0.196
31	0.181	0.183	0.257	0.839	0.440	0.208
31.5	0.503	0.278	0.328	0.558	0.501	0.431
32	0.750	0.316	0.369	0.425	0.161	0.083
32.5	0.375	0.124	0.229	0.381	0.489	0.537
33	0.511	0.124	0.306	0.358	0.696	0.240
33.5	1.858	0.673	0.578	0.532	0.449	0.379
34	0.859	0.276	0.333	0.616	0.315	0.217
34.5	1.582	0.908	1.163	0.593	0.124	0.123
35	0.782	0.742	0.645	0.859	0.461	0.571
35.5	0.510	0.596	0.287	0.292	0.167	0.041
36	0.927	0.482	0.496	0.598	0.558	0.147

**Table A3. Suitable Chinook juvenile rearing habitat by 0.5 river kilometer in the lower American River**

River Kilometer	Chinook Juvenile Suitable Rearing Habitat (gHSI $\geq$ 0.5) (Acres)					
	500 cfs	2,000 cfs	4,000 cfs	8,000 cfs	15,000 cfs	30,000 cfs
0	0.522	0.591	0.386	0.224	0.250	2.097
0.5	1.482	0.841	0.591	0.583	0.765	32.693
1	0.733	0.588	1.052	1.056	2.288	17.900
1.5	1.079	0.614	0.503	0.629	0.760	32.127
2	0.552	0.626	0.481	1.090	1.661	21.541
2.5	1.151	0.655	0.488	0.543	1.436	32.059
3	1.035	0.669	0.620	0.786	0.503	32.339
3.5	0.625	0.512	0.534	0.740	0.559	16.514
4	0.703	0.729	0.601	0.557	1.334	28.416
4.5	1.617	1.022	0.985	1.016	1.938	13.506
5	2.910	0.688	0.517	1.024	1.457	11.830
5.5	1.421	0.768	0.561	0.713	1.853	3.337
6	2.754	0.968	0.760	1.138	1.446	9.386
6.5	1.323	0.530	0.911	1.179	4.389	2.169
7	0.308	0.370	0.401	1.172	6.952	3.519
7.5	1.227	0.718	0.723	1.699	5.579	1.476
8	1.175	0.455	0.858	1.179	1.825	1.657
8.5	1.300	0.988	1.169	2.373	2.957	1.583
9	0.876	0.670	0.669	1.462	2.787	5.056
9.5	0.898	0.426	0.362	1.413	1.568	2.827
10	1.052	0.107	0.179	0.716	0.719	1.011
10.5	0.564	0.347	0.497	0.878	0.666	0.205
11	0.234	0.308	0.388	0.779	1.389	0.523
11.5	0.405	0.319	0.395	0.831	1.472	1.211
12	0.920	0.922	0.724	0.554	2.062	4.169
12.5	0.877	0.761	0.561	0.521	1.361	2.390
13	2.984	3.573	2.634	1.755	1.918	2.512
13.5	0.522	0.776	6.910	5.906	4.207	1.601
14	0.681	1.538	1.411	1.614	2.973	1.899
14.5	1.658	1.605	1.042	1.324	3.309	3.369
15	0.672	0.081	0.308	0.952	0.491	0.796
15.5	0.807	0.085	0.283	0.472	0.559	2.993
16	1.305	0.540	0.503	0.342	0.252	0.685
16.5	1.437	0.903	1.096	1.495	2.313	2.283
17	1.606	3.319	2.196	2.185	2.449	2.175
17.5	3.120	4.656	3.612	5.514	4.540	3.082
18	2.468	3.663	3.514	2.689	1.373	1.599
18.5	1.238	1.176	0.786	1.164	1.111	1.045
19	0.961	1.393	0.889	1.062	0.996	3.165
19.5	0.620	2.583	2.318	1.893	3.583	4.347
20	1.260	1.450	1.307	1.280	2.588	1.102
20.5	1.687	3.777	3.243	4.214	5.628	2.902
21	2.573	1.377	1.793	3.130	5.028	7.198
21.5	1.469	0.706	0.381	0.464	0.485	0.857
22	1.404	0.262	0.314	0.340	0.457	0.297
22.5	1.445	0.505	0.302	0.369	0.542	0.205
23	1.039	0.602	0.645	0.870	1.698	1.573
23.5	1.621	0.321	0.460	0.723	0.823	1.389
24	1.097	0.690	0.635	0.586	0.679	1.991
24.5	1.947	0.773	0.988	1.561	1.005	0.840
25	1.145	0.593	0.647	1.180	1.464	1.880
25.5	0.991	0.515	0.526	0.749	0.816	1.611
26	0.729	0.354	0.732	1.227	0.983	1.089
26.5	1.536	0.392	0.515	0.672	0.654	0.519
27	0.559	0.104	0.251	0.339	0.435	0.210
27.5	0.867	0.486	0.481	0.351	0.381	0.360
28	0.668	0.630	0.439	0.689	0.694	0.803
28.5	0.457	0.256	0.423	0.400	0.995	2.205
29	0.453	0.312	0.305	0.434	1.380	1.653
29.5	0.503	0.423	0.498	0.754	0.485	0.913
30	0.782	0.210	0.206	0.214	0.170	0.455
30.5	1.251	1.059	0.925	0.833	0.507	0.401
31	0.376	0.256	0.424	1.170	0.763	0.427
31.5	0.893	0.387	0.491	0.737	0.791	1.147
32	1.331	0.528	0.611	0.865	0.339	0.199
32.5	0.637	0.264	0.349	0.668	0.771	0.802
33	1.148	0.220	0.443	0.583	0.933	0.553
33.5	2.370	1.336	0.932	0.938	0.807	0.599
34	1.488	0.597	0.567	0.932	0.745	0.343
34.5	2.653	1.271	1.590	1.048	0.278	0.226
35	1.097	1.152	0.958	1.127	0.949	0.977
35.5	1.103	1.066	0.454	0.518	0.289	0.105
36	1.392	0.656	0.729	0.868	0.905	0.267