Deep in the Weeds: Sampling Juvenile Chinook in Inundated, Densely Vegetated Riparian Areas

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INTRODUCTION 1

Floodplains provide valuable habitat for the early life stages of many native fishes. Although anthropogenic modification of rivers in the Central Valley of California has significantly reduced the spatial extent of wetlands and floodplains [1], studies suggest that extant and restored floodplains are utilized as rearing habitat by juvenile Chinook salmon (*Oncorhynchus tshawytscha*). These habitats have been shown to provide juvenile Chinook with more abundant food resources [2], increased rearing habitat [3], and faster growth rates [4]. To take advantage of these potential benefits, juvenile Chinook have been demonstrated to move into floodplains when hydrology allows, and depart as floodwaters recede [5]. The ability of juveniles to rear in wetland and floodplain habitats may also generate more variation in migration timing and size at outmigration within the Chinook population by allowing some juveniles to spend more time rearing in freshwater systems [6]. Therefore, floodplain rearing has the potential to promote diversity in life history strategies, which is recognized as being essential for the maintenance of sustainable Chinook populations [7].

Large floodplain habitat (such as the Yolo Bypass) is lacking along a majority of the Stanislaus River owing to its incised channel. Instead, densely vegetated riparian areas are infrequently inundated during wet winters and springs. High levels of precipitation in the Sierras during the beginning of the 2019 water year resulted in flood management releases in the Stanislaus River that inundated these riparian areas and provided us the opportunity to assess the use of this ephemeral habitat by juvenile fall-run Chinook salmon.

Objectives

1. Assess spatial distribution of juvenile fall-run Chinook salmon in the Stanislaus River during extended high flows.
2. Characterize the habitats where juvenile fall-run Chinook salmon occur.
3. Compare sizes between juveniles observed in the main channel and flooded riparian area.

RESULTS 3

Hydrological Conditions

- From March 1 to April 15, overall discharge (at Ripon) has averaged 4,362 cfs (2,240 to 5,160 cfs) (Figure 1b).
- The total number of days of discharge > 4,000 cfs (37 days) far exceeds other high water years of 1997 (8 days) and 2006 (7 days) (Figure 1b).
- In terms of duration, in 2019, there have been 23 and 14 continuous days > 4,000 cfs; 1997 had 8 days and 2006 had 5 days (Figure 1b).
- Submerged terrestrial vegetation dominated the seining sites; whereas electrofishing sites had a mix of habitat types (Figure 2 and 5).

Fish Size Characteristics

- Fish sampled in flooded margins appear to be larger than in the main channel but there is some gear size-selectivity with seining and e-fishing (Figure 3).
- Overall, more fish were caught at the Oakdale RST than at the Caswell RST, but the size of fish was slightly greater at Oakdale (Table 1).
- The slopes of the lower quantiles (2, 5, 10) were not significantly different from 0 or substantially different between traps over the same period (Figure 4).
- The slopes of the upper quantiles (90, 95, 98) were not substantially different between traps over the same period (Figure 4).

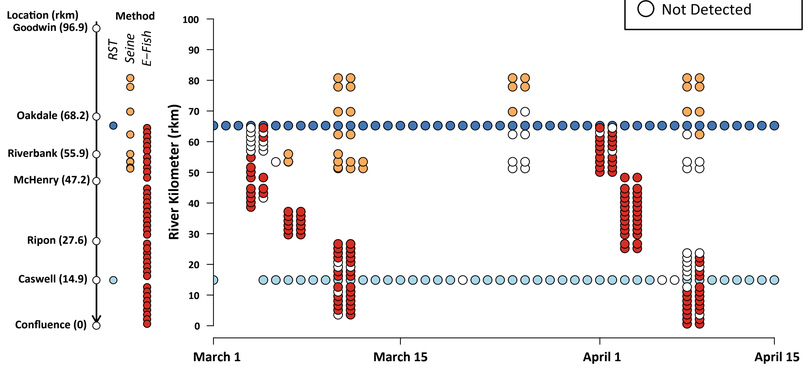

Figure 1a: Spatial and temporal context of sampling with color indicating presence of juvenile Chinook detected in sample.

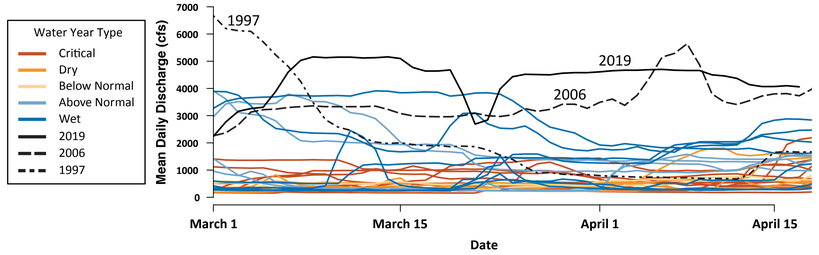

Figure 1b: Mean daily discharge data from March 1 - April 15 for the years 1990 to 2019. Color denotes the water year type and line type denotes extreme high water years during this period (1997, 2006, and 2019).

METHODS 2

Rotary Screw Trap (RST) Sampling

- Oakdale trap - rkm 65.2; operated by FISHBIO (Figure 1a).
- Caswell trap - rkm 14.9; operated by Pacific States Marine Fisheries Commission (PSMFC) (Figure 1a).
- Continuous sampling of the main channel.
- Oakdale and Caswell data from March 1st through April 15th.

Electrofishing

- Boat-mounted electrofishing.
- Thirty-seven (37) sample sites between rkm 0.3 and rkm 64.5 (Figure 1a).
- First two weeks of March and April.
- Each site was 0.3 rkms in length and sampled up to four times.
- Mean effort per site was 14 minutes (range 5 to 46 minutes).

Seining

- Six sample sites between rkm 51.3 and rkm 80.8 (Figure 1a).
- March 7, 11, 12, 13, 25, and 26, and April 8 and 9
- Three repeat hauls per site per event.
- Mean seined area was 70 m² (range 25 to 139 m²).

Data Analysis

- Visually assessed fork length distributions across all gears.
- Performed quantile regression of RST fork lengths versus day of year.
  - Accounts for change in variation of fish size and growth over time.
- Compared quantile slopes between Oakdale and Caswell traps.
- R statistical software [8] and the quantreg package [9].

Figure 2: Photo series of habitats where juvenile Chinook salmon were sampled during boat electrofishing. Habitat types from left to right are: Overhanging Vegetation, Rip-Rap, Submerged Vegetation, and Woody Debris. A photo of Open Water Habitat is not shown.

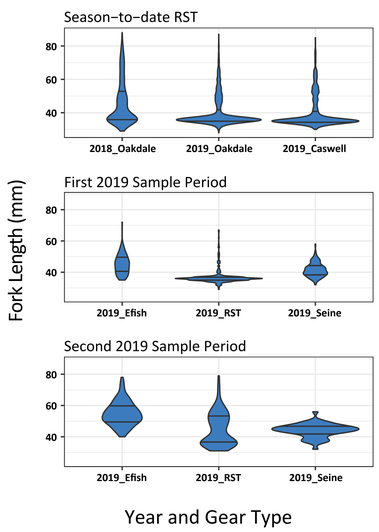

Figure 3. Fork length violin plot with 2018 RST data for comparison.

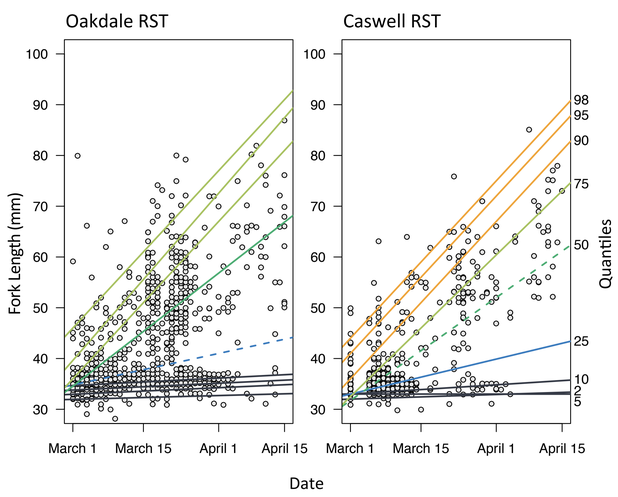

Figure 4. Quantile regression plots for juvenile Chinook salmon captured and measured at Caswell and Oakdale RSTs (March 1 - April 15). Points denote the date and fork length (mm) of individual fish and line colors denote significant differences in slopes between quantiles.

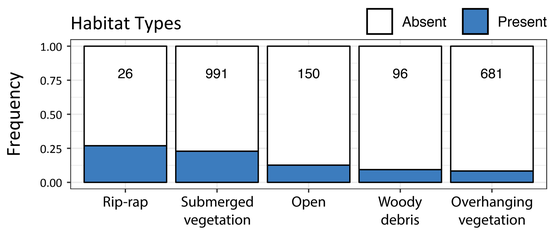

Figure 5. Proportion of points sampled where juvenile Chinook salmon were captured by habitat type during boat electrofishing in March from video review. April data not included. Numbers denote the number of each habitat sampled.

Table 1. The total number of juvenile Chinook captured by each sampling method between the dates of March 1st and April 15th, as well as the range in fork lengths, mean fork length, and median fork length of Chinook sampled by each respective method.

Sampling Method	Juvenile Chinook Captured	Range of Fork Lengths (mm)	Mean Fork Length (mm)	Median Fork Length (mm)
Oakdale RST	1,432	28-87	45.5	43
Caswell RST	615	30-85	40.0	35
Electrofishing	733	35-101	54.1	53
Seining	340	32-65	42.9	42
Total	3,120	-	-	-

DISCUSSION 4

We documented the presence of juvenile fall-run Chinook in inundated, densely vegetated riparian areas throughout the lower Stanislaus River. The size distribution of juvenile Chinook captured by electrofishing channel margins and seining inundated riparian area was similar to the juveniles collected by the RSTs in the main channel. However, there appeared to be a gear selectivity bias.

How does this inform restoration?

1. Given that the slopes of the upper quantiles were similar between traps, this suggests that both traps are sampling similar distributions of migrating Chinook salmon. In addition, Chinook salmon captured at Caswell were not larger than those captured at Oakdale (our expectation). Combined, this suggests no differential growth opportunities between the upper, rearing reach (sampled by Oakdale) and the lower, migratory reach within the timeframe of our data.
2. Many San Joaquin tributaries are limited in available habitat that could be restored to a large functioning floodplain.
3. Inundated, densely vegetated riparian areas provide slow water habitat and cover for migrating salmon along the majority of the sampled reach.
4. Restoration activities that increase the inundation frequency of smaller riparian areas during juvenile migration season might be more pragmatic than restoration of large floodplain areas. Ideally, these could be inundated at a large range of discharge levels.

Additional questions and research needs:

1. Juveniles occupy this habitat but the growth benefit from these habitats still needs to be investigated. More focused studies on this particular question would provide better insight than our current analysis.
2. Are juveniles rearing in this habitat or using it as cover during daylight hours?
3. What prey sources are available for juvenile salmon in this type of habitat?
4. Do predators also occupy this habitat?
5. Need to compare differences in slopes of upper quantiles between years when these habitats are inundated and are not inundated.

Acknowledgements

Thank you to Kassie Hickey (PSMFC) and Eric Bradbury (PSMFC) for providing Caswell RST data. We thank Dee Thao for poster design and layout. Funding for sampling for the various projects was provided by the Oakdale and South San Joaquin Irrigation Districts and the Tri-Dam Project.

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