CHAPTER 6

COMPLIMENTARY STUDIES RELATED TO THE VAMP

Throughout 2007 several fishery studies were conducted to advance the understanding of juvenile salmon abundance and survival in the San Joaquin River basin. Following are summary reports of the information developed in each study.

Review of Juvenile Salmon Data from the San Joaquin River Tributaries to the South Delta During January through June, 2007

Contributed by Tim Ford, Turlock and Modesto Irrigation Districts, and Andrea Fuller, FISHBIO Environmental

The VAMP includes protective measures for San Joaquin River (SJR) smolts during a 31-day period in April and May, and evaluations are conducted annually to determine how these measures (i.e., river flow and exports) relate to delta survival. However, juvenile salmon from the spawning areas of the Stanislaus, Tuolumne, and Merced rivers (referred to here as tributaries) can migrate to the SJR and delta over a longer season that may range from January to June. Their migration and rearing patterns vary among tributaries and among years in response to flow releases, runoff events, turbidity, and other factors.

During 2007, rotary screw trapping was conducted near the confluences of the Stanislaus, Tuolumne, and Merced Rivers with the SJR. Seining was also conducted in the SJR from below the HOR to upstream of the Tuolumne River confluence. This review presents data from those rotary screw traps (RST) and seining to identify the presence and movement of juvenile salmon from the tributaries into the mainstem San Joaquin River relative to observations at the Mossdale Trawl and in CVP and SWP salvage facilities. Stanislaus River RST monitoring was conducted at River Mile (RM) 9 (Caswell site) during 11 Jan – 22 Jun; Tuolumne River RST monitoring was conducted at RM 5 (Grayson site) during 23 Mar – 29 May; and Merced River RST monitoring was conducted at RM 2 (Hatfield site) during 25 Jan - 01 Jun. Weekly seining during Jan-Jun was done at up to 8 sites from River Mile 51 (Dos Reis) to River Mile 83 (North of Tuolumne River) and 2 other sites were seined every 2 weeks from mid-January to late May at River Mile 78 and 90. Trawling was conducted in the San Joaquin River at Mossdale near RM 54 (downstream of the tributaries, and just upstream of the Head of Old River) with a schedule of three days/week 03 Jan – 30 Mar; five days per week 02 Apr – 20 Apr; daily during 23 Apr – 25 May; and three to five days per week during 29 May – 30 Jun. Trawling was suspended during 02 Jun – 10 Jun due to Delta smelt concerns. Although salvage data of unmarked salmon does not distinguish which salmon originate from the San Joaquin tributaries, they can be compared to timing, abundance, and size of salmon collected in the San Joaquin basin monitoring. Flow and rainfall patterns in the basin are shown in Figure 6-1.

The seasonal peak catch of fry in the Stanislaus River RST (Figure 6-2) occurred on March 1 following increasing reservoir releases and rain events during 25 Feb – 01 Mar. The Merced River RST sampling suggests that fry did not migrate out of the Merced River during 2007 (Figure 6-3). RST sampling was not conducted during the fry outmigration season on the Tuolumne River, but Tuolumne seining recorded no salmon down to, or below, Modesto, where Dry Creek runoff enters the river, thus fry outmigration also likely did not occur in the Tuolumne River (Figure 6-4). Relatively few early fish were observed at the Mossdale trawl (Figure 6-5). It appears that peak fry migration from the Stanislaus River in 2007 was not detected at Mossdale indicating that the juveniles may have remained in the lower San Joaquin River above Mossdale and/or the relative efficiency of the trawl for fry-size salmon is less than at the rotary screw trap. However, high densities of fry at Mossdale have been detected by the Mossdale trawl in other years (SJRGA 2005). Seasonal peak catch occurred at Mossdale on 23 Apr (Figure 6-5), shortly after peak smolt catches on the Stanislaus River on 21 Apr (Figure 6-2) and coincident to the peak densities recorded at the salvage facilities (Figure 5-23). Many salmon may have also passed Mossdale undetected during 21-22 Apr as a result of no sampling effort on these days. Seasonal peak catches were observed on the Merced River on 24 Apr (Figure 6-3) and on the Tuolumne River during

Figure 6-1
San Joaquin Basin Flows and Rainfall

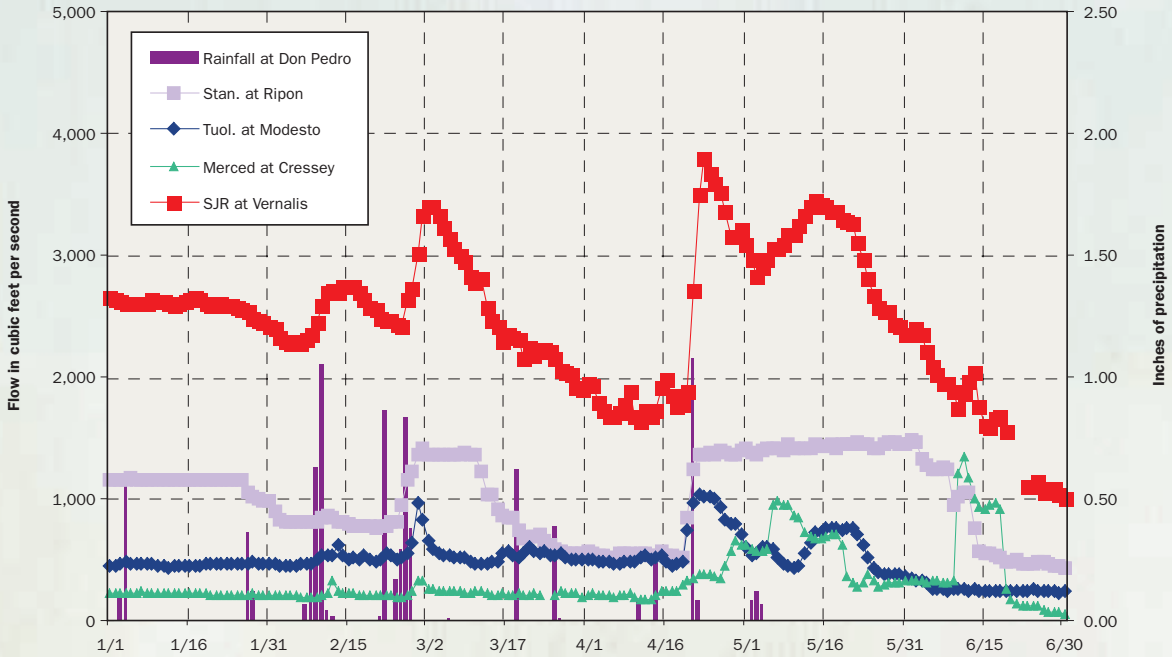


Figure 6-2
Stanislaus screw trap catch of unmarked juvenile Chinook salmon

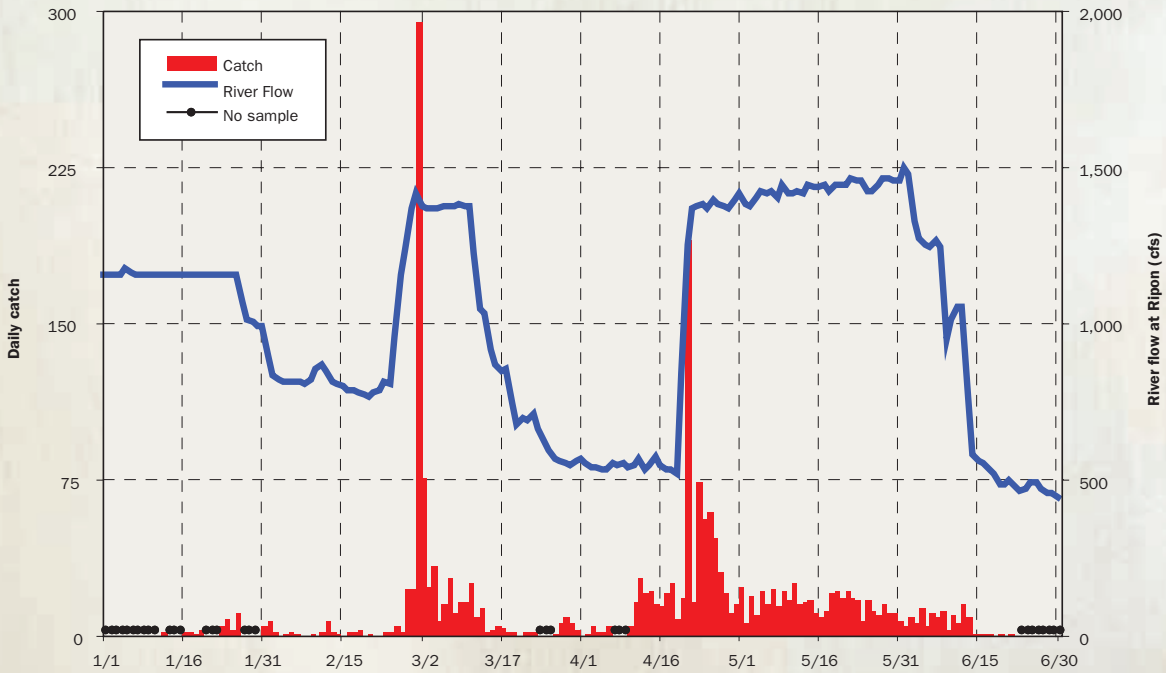
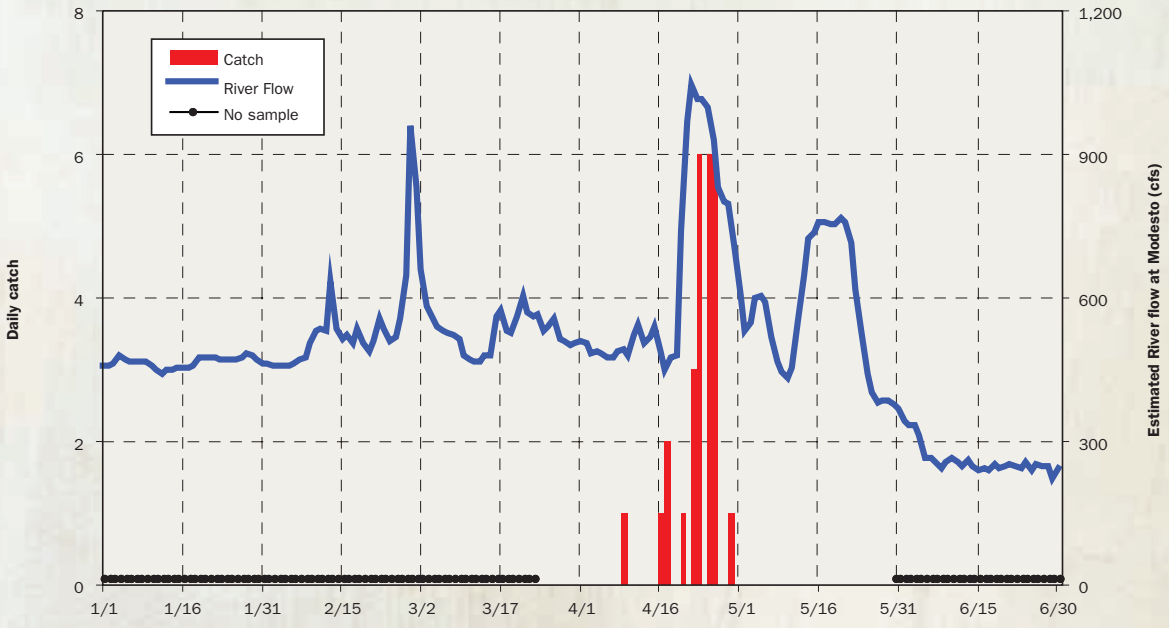


Figure 6-3
Merced screw trap catch of unmarked juvenile Chinook salmon

Figure 6-4
Tuolumne screw trap catch of unmarked juvenile Chinook salmon



23-26 Apr (Figure 6-4), and these peaks were detected at Mossdale during 28-29 Apr. Seining in the SJR only captured two salmon prior to VAMP: one yearling salmon (155 mm) captured at Sturgeon Bend (RM 74) on 01 Mar and one young-of-year salmon (56 mm) captured at Big Beach (RM 63) on 29 Mar.

Average size in RST and trawl catch and salvage (Figure 6-6) shows that most fish observed prior to mid-March averaged <50 mm fork length (FL). Both the trawl and salvage are relatively less effective at capture of fry (salmon less than 50 mm long). Average size at all locations typically increased by early April to >70 mm FL and to >80 mm FL by early May (Figure 6-6). Low abundance of juvenile salmon was observed by 01 May in the Tuolumne River, mid-May in the Merced River, and mid June in the Stanislaus River and at Mossdale. To obtain more useful information on salmon movement into the Delta, daily monitoring at the lower end of each of the three San Joaquin tributaries and at Mossdale for the entire season (January through June) is a high priority. Further evaluation of the trawl and salvage efficiency on smaller juvenile salmon is necessary. These data would help to refine existing protective measures for smolts, if warranted, and to identify alternative strategies that may protect a larger proportion of the juvenile salmon population migrating from the San Joaquin tributaries.

2007 Mossdale Trawl Summary

Contributed by Jason Guignard
California Department of Fish and Game

Introduction

Monitoring for the fall-run chinook salmon smolt out-migrant population, from the San Joaquin drainage, is conducted by CDFG two miles downstream of Mossdale Landing, County Park (river mile 56), and just upstream of the Old River confluence (Figure 6-7). This measurement of timing and production of the out-migrating fall-run Chinook salmon smolts has been performed at this location since 1988 in order to:

1) Determine annual salmon smolt production in the San Joaquin Basin,

2) Develop smolt production trend information,

3) Determine timing and magnitude of smolt out-migration into the Delta from the San Joaquin tributaries.

Methods

Sampling is performed with a 6 x 25 foot (1.87m x 7.6m) Kodiak trawl net. The Kodiak trawl uses two boats to pull a net equipped with spreader bars, wings, and a "belly" in the throat of the net (to improve capture vulnerability). The cod end of the trawl net is secured using a rope. The sampling intensity was 5 days a week from April 2 to April 20, and then increased into 7 days a week from April 23 to May 25. The sampling effort was reduced back to 5 days a week during May 29 to June 15, and sampling was actually suspended briefly from June 4 to June 8 due to delta smelt concerns. The entire sampling period was from April 2 to June 15, 2007 with a total of 57 sample days out of the study period of 75 days. All trawling occurred during daylight hours, starting around 0800 hours. A sampling day usually consisted of 15 tows at 20 minutes per tow, although the first three weeks and last four weeks of sampling had 10 tows per day. Sampling is also conducted 3 days per week between mid- June and April by the USFWS in Stockton.

Water temperature, turbidity, weather, and beginning tow time were recorded for each tow. Velocity was recorded by using a digital flow meter model 2030R that is made by General Oceanics Inc. A Garmin GPSMap 172c was used to map the location of all sampling tows. This mapping is being done to evaluate differences in catch rate throughout the sampling area (Figure 6-8). The mean daily river flow data that is used in this report were taken from the U.S. Geological Survey mean daily stream flow gauge at Vernalis.

All fish were identified to species and enumerated. The first 20 per tow of all species, except Chinook salmon, were also measured. Chinook salmon were checked for a clipped adipose fin and/or dye mark. All non-marked Chinook salmon were considered "natural" for the purpose of this study. All Chinook salmon were measured (fork length, mm). Chinook salmon that had a clipped adipose fin was measured, individually bagged, and labeled and saved for coded wire tag processing.

Analysis

The 2007 natural smolt production from the San Joaquin drainage was estimated by two different methods. The first method (smolt/ac-ft method) involves taking the actual number of non-marked Chinook salmon and dividing by the actual volume sampled to get Chinook/ac-ft. This number is then expanded by the daily mean flow recorded at Vernalis for a 5-hour index and expanded again for a 24-hour daily estimate. These daily average smolt densities are then expanded by multiplying by the daily mean flow recorded at Vernalis (Figure 6-9). Production for days not sampled within the study period were estimated by averaging smolt/ac-ft for the 2 days before and 2 days after the non-sampled period.

The second estimate (regression vulnerability method), which we believe to be a more accurate estimate, due to the uneven distribution of smolts in the channel, is determined based on the recapture rates of dye marked

Figure 6-5
Mossdale kodiak trawl catch of unmarked juvenile Chinook salmon

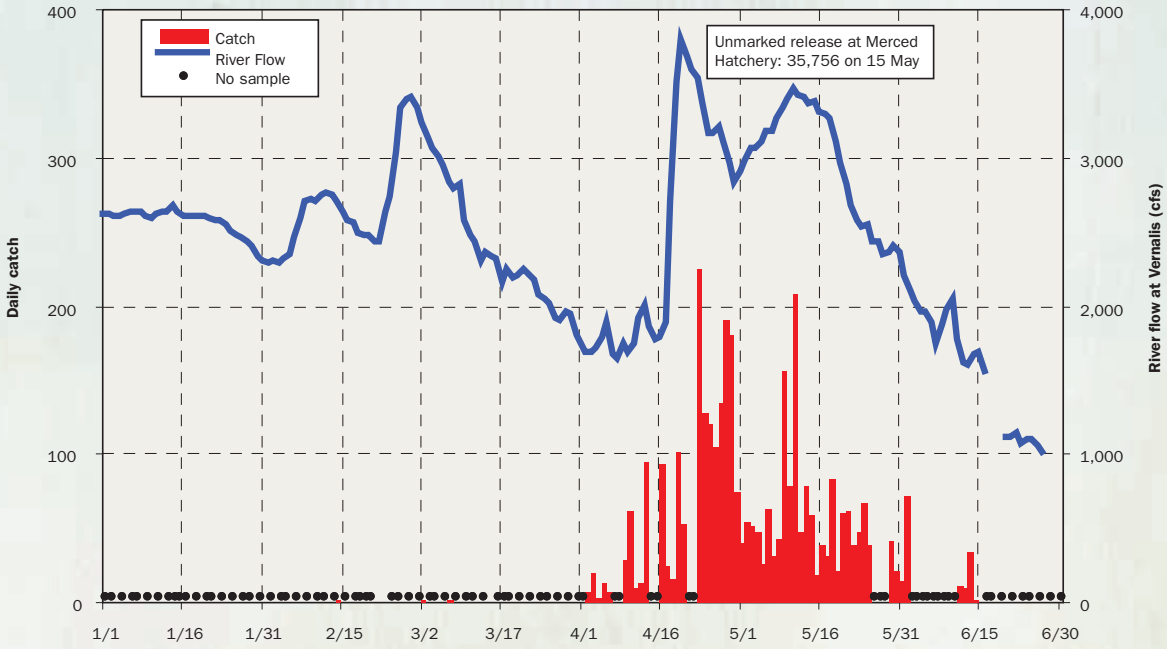


Figure 6-6
Daily average forklength of unmarked juvenile Chinook salmon

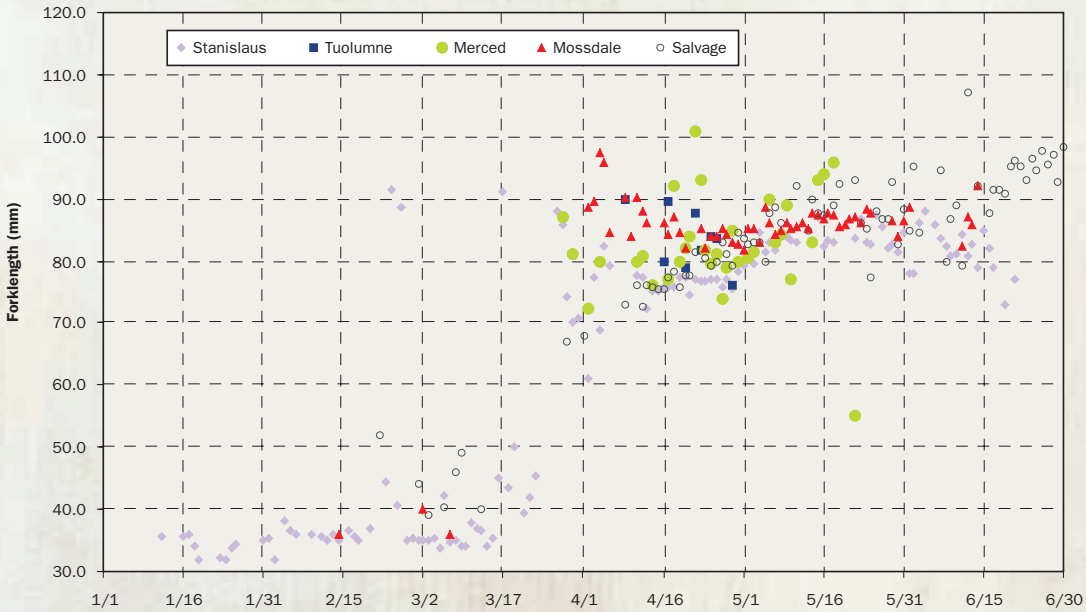


Figure 6-7
Tow Location, Mossdale to Old River

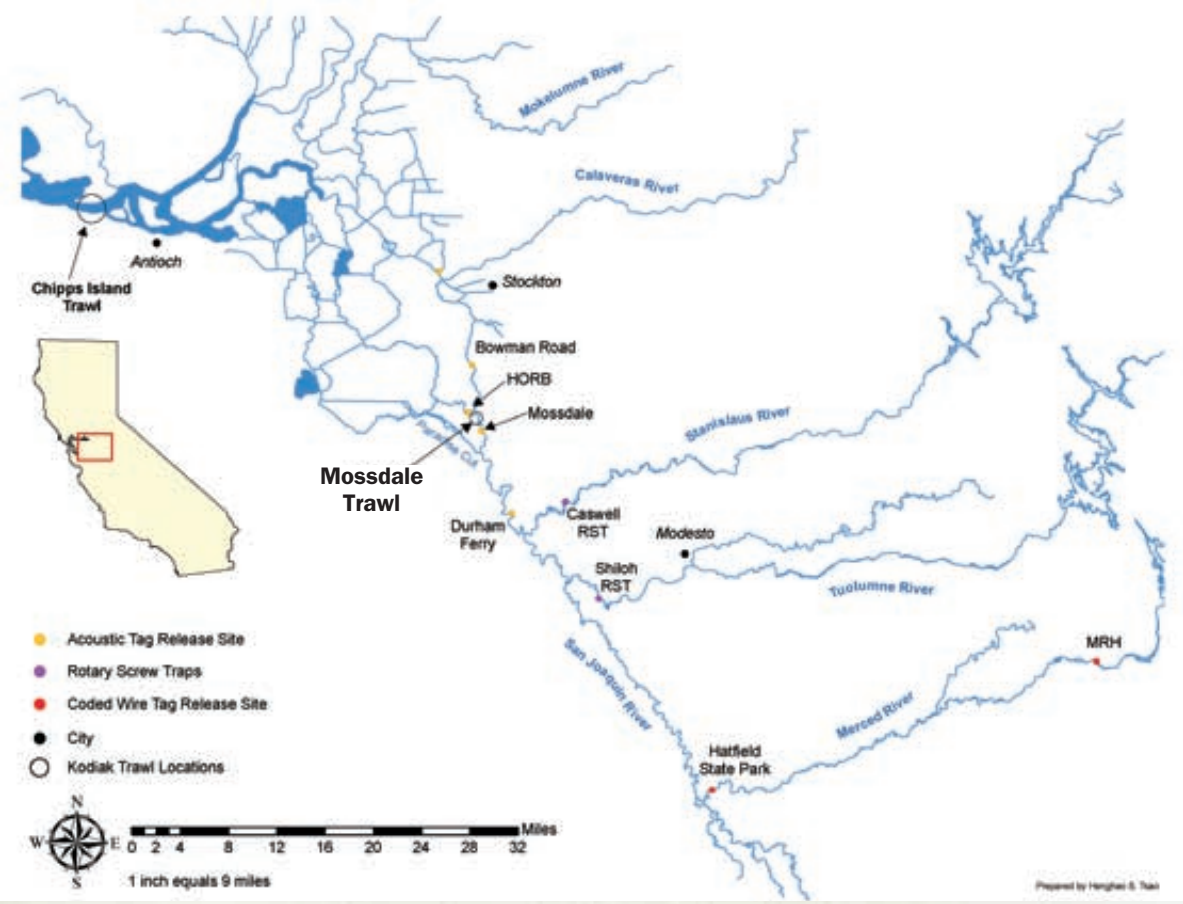


Figure 6-8
Mossdale Sampling Tows

Figure 6-9
Expanded daily catch of non-marked Chinook based on vulnerability estimates and flow at Vernalis

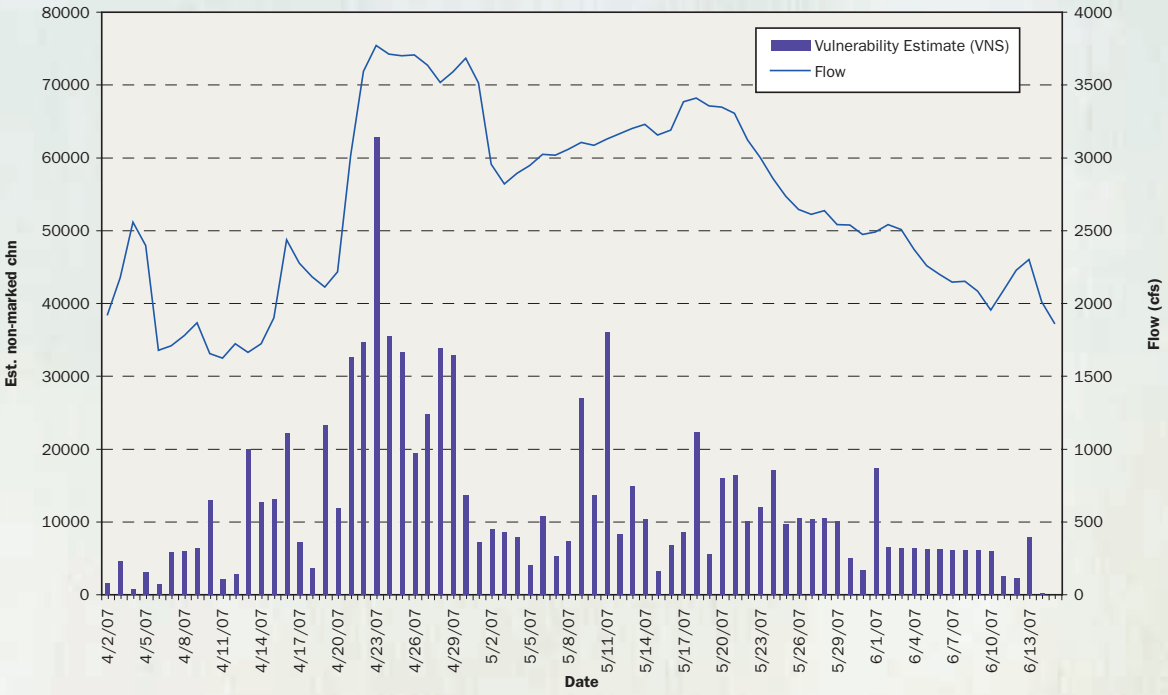
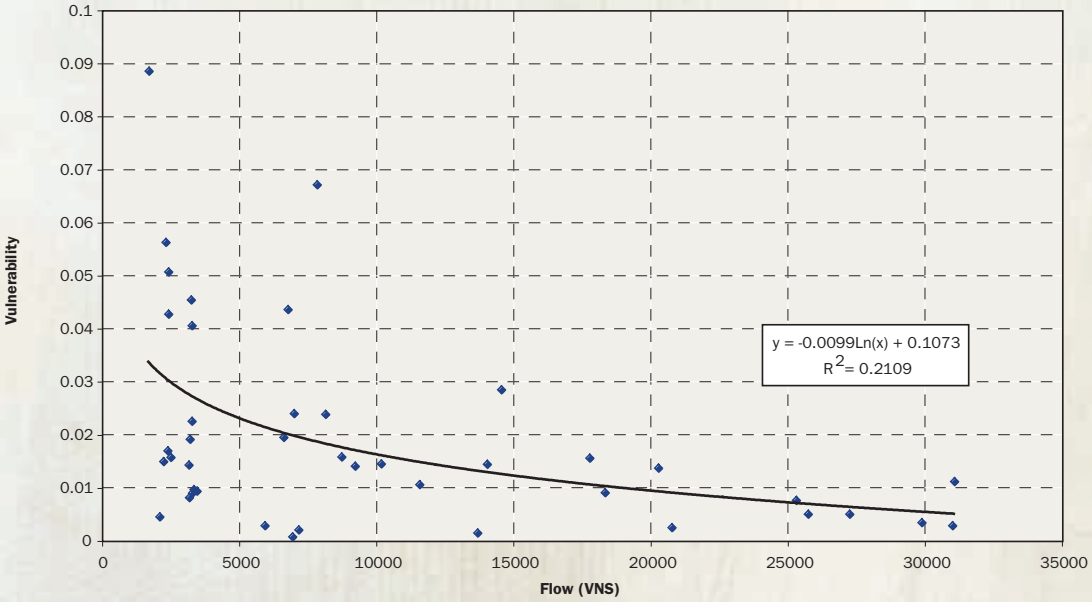


Figure 6-10
Natural log of 1989- 2006 efficiency estimates vs. flow at Vernalis.



vulnerability release groups. Due to the low number of smolts produced at Merced River Hatchery, there were no vulnerability tests performed during the 2007 sampling period. Instead, vulnerability was estimated based on the natural log of vulnerability versus flow at Vernalis from previous years tests (1989-2006) (Figure 6-10). This number is then extrapolated out to a 5-hour index and a 24-hour seasonal estimate. Production, for days not sampled within the study period was estimated based on the average smolt catch and minutes towed for the 2 days before and 2 days after the non-sampled period.

Smolt Production Index Calculation (Smolt/ac-ft Method):

The natural smolt index estimates (EI) are calculated as follow:

$$E_I = \sum_{i=1}^{n=75} \left[\left(\frac{C_i}{V_{Ti}} \right) \left(V_{Pi} \right) \left(\frac{24}{5} \right) \right]$$

Where:
n = days in the index period
C = daily non-marked Chinook catch
VT = daily volume of trawl sampled
VP = daily 5-hour volume of water passing Mossdale
i = ith Day

The 95% confidence interval around this index was calculated as +1.96 x the Standard Deviation of the mean smolt density (smolt/ac-ft) in the trawl catch over the 75 days.

Vulnerability Expansion Calculation (Regression Vulnerability Method):

$$E_V = \sum_{i+1}^{n=75} \left[\frac{\frac{C_i}{V_i}(60*24)}{T_i} \right]$$

Where:
n = days in the index period
C = daily non-marked Chinook catch
V= daily vulnerability estimate
T= minutes towed
i = ith Day

For the purpose of the analysis, vulnerability to the trawl was assumed from the beginning of the first tow detected to the end of the last tow detected on the day of release where marked fish were detected. Detection of marked fish subsequent to the day of release was not used in the analysis (this was less than 5 fish total for all releases). Travel time (from release point to trawl), time vulnerable to the trawl and the percent vulnerability as related to flow were determined for each test group.

Results

Between April 2 and June 15, 2007 3,392 non-marked Chinook salmon smolts were captured in the Mossdale trawl. Daily capture of non-marked salmon ranged from 0 – 225 individuals with an average of 61. Average forklength of non-marked Chinook was 85.2 millimeters (mm) and ranged from 62 - 162 mm. A total of 378 adipose fin clipped Chinook were captured between April 25 and May 18, 2007. The average forklength of marked Chinook was 96.4 mm and ranged from 80 – 118 mm.

Smolt production estimates for the San Joaquin basin ranged between 273,798 using the smolt/ac-ft estimate and 920,006 using the trawl vulnerability estimate (Table 6-1). The regression vulnerability estimate is thought to be more accurate than the smolt/ac-ft index method because it should account for an uneven distribution of migrating smolts in the river channel.

However we have assumed that the average vulnerability estimate applies to the catch in 2007. That may make the estimate of abundance using the trawl vulnerability method more uncertain than in past years where vulnerability was actually measured and applied.

Forty steelhead/ rainbow trout (RBT) were captured during the 2007 sampling period. All RBTs were measured and returned to the river. Forklength ranged from 200- 330 mm (238 mm average), and all samples exhibited advanced stages of the smoltification process. This is the highest number of steelhead captured since CDFG started sampling at Mossdale in 1988 (Figure 6-11).

Survival Estimated for CWT Releases Made in the Merced River

Contributed by Pat Brandes, U.S. Fish and Wildlife Service

Coded wire tagged salmon from the MRH were released in the Merced River between April 20 and May 8, 2007 as part of independent (complimentary to VAMP) fishery investigations. Releases were made in the upper and lower reaches of the Merced River (Merced River Hatchery and Hatfield State Park, respectively).

Survival indices to Chipps Island of lower Merced releases made at Hatfield State Park include mortality down the mainstem San Joaquin River, as well as, through the Delta (Figure 6-7). Chipps Island survival indices of the lower Merced River groups were 0.036 for the first group released on April 24. No recoveries were made at Chipps Island from the later group released on May 8th. Survival indices using Chipps Island recoveries in 2006 ranged between 0.019 – 0.106 for the groups released in the lower Merced River at Hatfield State Park. In past years survival has been similar for these groups to those released at Durham Ferry and Mossdale.

If sufficient numbers of fish are recovered in the Chipps Island trawl, survival indices can be generated for groups released on the upper Merced River (MRH). Comparison of survival indices of groups released upstream and downstream and recovered at Chipps Island provides an estimate of survival through the Merced River. This is accomplished by dividing the upstream group survival index by the downstream survival index. Unfortunately, insufficient numbers of fish were recovered from the first release group to generate survival extimates (i.e., only 1 fish from the upper Merced River and 2 fish from the lower Merced River.) No recoveries were made at Chipps Island for the second release groups from either the upper or lower Merced River release groups. Ocean recoveries will be available for these groups in future years and will provide an additional source of recoveries of which to use to estimate survival through the Merced River in 2007.

Recoveries at Chipps Island in 2007 were made prior to May 5, 2007. Sampling at Chipps Island was terminated on May 26, 2007 due to concerns related to the low population levels of delta smelt and the potential to catch some at Chipps Island.

Comparison of Lower Merced Releases with Sacramento River Delta Releases

Contributed by Pat Brandes, U.S. Fish and Wildlife Service

As in previous years, marked fish from the Feather River were released on the Sacramento River near West Sacramento in 2007. Three groups were released to index survival through the Delta for juvenile salmon originating in the Sacramento basin. Comparison of survival between the Sacramento released fish and those released in the lower Merced may provide some insight on the variation in survival between basins.

As mentioned previously, in late May of 2007, trawling at Chipps Island was suspended due to delta smelt concerns and affected the recoveries of some of the groups released at Sacramento. For instance there were no recoveries for the last group released at Sacramento on 5/14/07. The survival index for the first release on 4/16/07 at Sacramento was 0.369. This may index the true survival as it is likely most of the released fish had passed Chipps Island prior to the termination of sampling. The survival index for the second release made at Sacramento on 4/30 was 0.039. This group may have also been affected by the lack of sampling in late May. However, if we just restrict the comparison between the first Sacramento group and the first lower Merced River group, survival was much greater for the Sacramento group (0.369) than the lower Merced group (0.036).

Survival indices are typically higher for smolts migrating through the Delta from Sacramento than for smolts emigrating past Mossdale. It is unclear why this is the case although smolts entering the Delta from Mossdale are generally exposed to lower river flows than on the Sacramento River and smolts from the San Joaquin basin migrate in closer proximity to the CVP and SWP pumping plants. In 2007, samples taken from the acoustically tagged fish used in the VAMP studies had PKD as many of the VAMP fish have had in past years. All of these factors and others may result in the lower survival detected through the Delta for juvenile salmon originating from the San Joaquin basin.

Figure 6-11
Annual rainbow trout/steelhead catch and average foklength at Mossdale

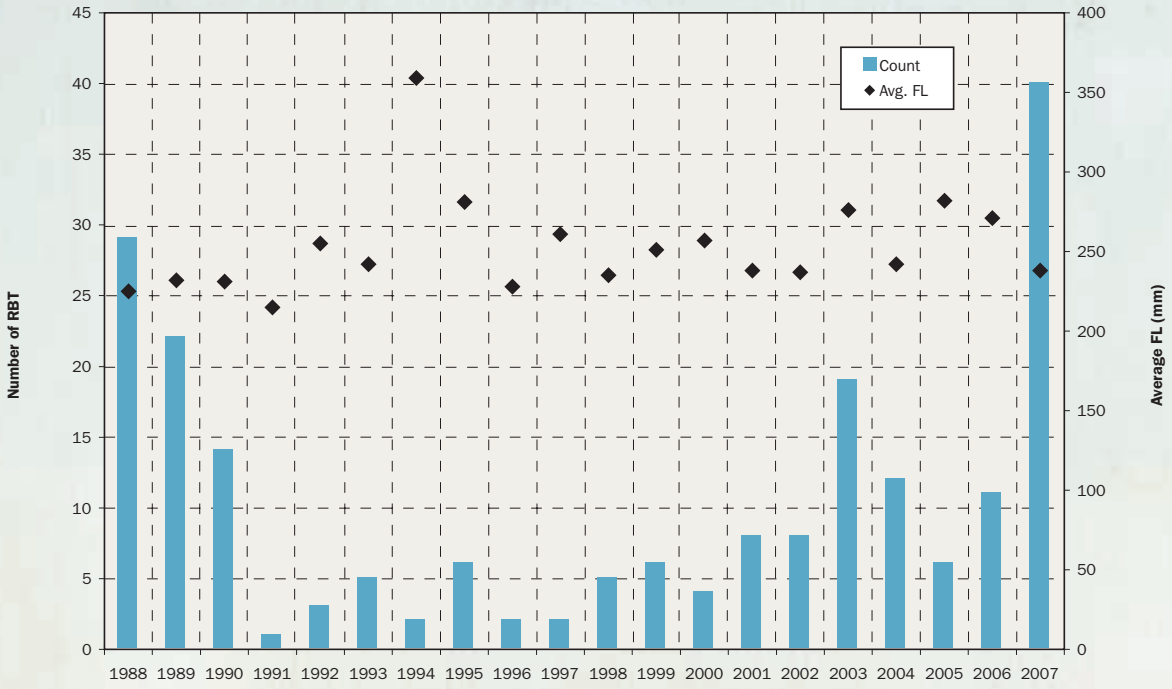


Table 6-1
Smolt production seasonal estimates and sampling period for the duration of the study.

Year	Sampling Period (Days)	Percentage of Days Sampled (%)	Smolt/ac-ft Estimate	Vulnerability Smolt Production Seasonal Estimate** (95% confidence range)
2007	75	76.0	273,798+ 7,490	920,006
2006	75	85.3	848,394 + 12,888	1,808,143 : (1,749,531- 1,866,755)
2005	89	80.9	363,800 + 14,700	621,403 : (388,884- 1,119,550)
2004	61	88.5	92,500 + 66,500	297,348 : (191,222- 665,160)
2003	88	80.7	107,500 + 60,300	368,424 : (277,626- 545,121)
2002	74	87.8	229,100 + 557,100	2,254,647 : (1,455,066- 5,179,591)
2001	103	78.6	279,800 + 286,000	928,996 : (586,790- 2,228,789)
2000	88	81.8	211,100 + 181,900	484,703
1999	119	71.4	146,900 + 63,500	438,979
1998	99	67.7	1,075,000 + 562,800	2,844,637
1997	92	69.6	168,600 + 89,400	635,517
1996	89	85.4	381,900 + 626,900	1,155,319
1995	60	78.3	1,108,900 + 2,640,000	3,361,384
1994	63	73.0	67,500 + 62,200	453,245
1993	83	61.4	54,200 + 21,800	269,035
1992	72	44.4	23,600 + 6,300	280,395
1991	59	66.1	*	538,005
1990	82	69.5	*	263,932
1989	54	100	*	4,241,862

*Data is currently being reevaluated.
**2001- 2006 production estimates based on the annual vulnerability tests, 1989-2000 estimates based on the natural log of all vulnerability tests (1989-2005).